S. Hrg. 101-399

DEGRADABLE COMMODITY PLASTICS PROCUREMENT AND STANDARDS ACT OF 1989

HEARING

BEFORE THE

COMMITTEE ON GOVERNMENTAL AFFAIRS UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

S. 1237

TO REQUIRE THE ADMINISTRATOR OF THE GENERAL SERVICES ADMINISTRATION TO ENCOURAGE THE USE OF PLASTICS DERIVED FROM CERTAIN COMMODITIES, AND TO INCLUDE SUCH PRODUCTS IN THE GENERAL SERVICES ADMINISTRATION INVENTORY FOR SUPPLY TO FEDERAL AGENCIES, AND TO ESTABLISH AN INTERAGENCY COUNCIL ON BIODEGRADABLE STANDARDS FOR THE DEVELOPMENT OF UNIFORM DEFINITIONS, STANDARDS, AND TESTING PROCEDURES FOR DEGRADABLE PLASTIC PRODUCTS MADE FROM CERTAIN COMMODITIES, AND FOR OTHER PURPOSES

JULY 18, 1989

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DEGRADABLE COMMODITY PLASTICS PROCUREMENT AND STANDARDS ACT OF 1989

TUESDAY, JULY 18, 1989

U.S. SENATE,
COMMITTEE ON GOVERNMENTAL AFFAIRS,
Washington, DC.

The Committee met, pursuant to notice, at 9:30 a.m., in room SD-342, Dirksen Senate Office Building, Hon. John Glenn (Chairman of the committee) presiding.

Present: Senators Glenn, Levin, and Kohl.

Staff present: Susan Carnohan, Kathy Connolly, Ruby Demesme, Brian Dettelbach (Senator Glenn); Elise Bean (Senator Levin); and Chris Coffin (Senator Kohl).

OPENING STATEMENT OF CHAIRMAN GLENN

Chairman GLENN. The hearing will be in order.

Good morning and welcome to this hearing before the Committee on Governmental Affairs on Senate Bill 1237, the Degradable Commodity Plastics Procurement and Standards Act of 1989.

I believe one of the major issues facing American agriculture today is the development of new nonfood uses for our Nation's agricultural commodities. Let me give just a little background on this, because the hearing this morning fits into a pattern of other interests and promotions that the Committee has looked into in the last couple of years.

We are so very good at research in this country, and nowhere is that more evident than in agricultural research throughout history. We have concentrated most of that research, almost all of it exclusively, on production research—how do we produce more—and we have been quite good at that.

Our agricultural surpluses in this country come not only from the fact that we have great plains out there, but the fact that we have learned how to stabilize soils, how we have learned to fertilize, how we have developed hybrids. And I use the example of when I was a boy back home in Ohio, a good corn crop was somewhere around 47-48 bushels per acre. Last year in Ohio we averaged 137 bushels per acre. That was not all just from the farmers doing three times more work. In fact, maybe they did less work than their forefathers back in those earlier times. It was a result of our research that we learned new things.

Now, in this year's budget, we have $570 million for the Agricultural Research Service; $25 million of that is for utilization research, use research—that is, not just research on how to produce

more every year, but use research. Another $13 million goes for nonfood use research, and actually most of that gets used for wool and cotton. So we come down to only $3.5 million of nonfood uses for traditional food crops like corn, wheat, and so on. It's just a pittance being put into this area of nonfood uses research.

Now, the legislation we are considering today addresses the need to look more into nonfood uses by encouraging the development and marketing of commodity based degradable plastics through government procurement and usage. Government can help give this a jump start, if you will.

There are a number of degradable products, ranging from bags, jugs, containers, toys, textiles, building materials, and office supplies, being made today by adding copolymers such as cornstarch to conventional plastic resins. Research shows that when these items are disposed of in an ecologically active environment such as a landfill, natural organisms in the soil or elsewhere can attack and decompose the products.

I have a whole host of samples in front of me this morning. Here are bottles, water jugs, diapers that are now made to be degradable, leaf and grass bags, and shopping bags. These are all made with cornstarch polymers.

Here is a fast-food container for a quarter pound cheeseburger with the "Hardee's" name on it that's degradable when put into a landfill. I do hope this diaper doesn't biodegrade before you get it off the baby, of course.

But these are just a few examples of what we can do now with our ongoing research using cornstarch, and I don't know how many tens upon tens of millions of bushels of corn we use now just for this, but I do know that the number, whatever it is, can be widely expanded. And that is just what we are trying to do with this bill.

Think of all the possible benefits we stand to gain from this emerging technology; greater demand for farm products, I've already mentioned; expanded international trade opportunities; smaller Federal outlays for farm programs.

In addition, we are now faced with growing solid waste disposal problems. Landfill space is rapidly dwindling, and the solution to this problem will be, obviously, a mix of several initiatives, such as recycling, advanced incineration methods, and new disposal techniques. I believe that degradable plastics can play a role in this effort.

At our hearing last year most witnesses supported the intent of my legislation. However, it also became clear that to make the idea work uniform standards, definitions, and testing methods for degradable plastics would have to be established. None exist today.

As we promote the development and use of these items, we need to reach an agreement on what the term "degradable" means. And further, what constitutes a "degradable" product. They are very basic questions and that is the reason, in part, that we are here today.

In this new legislation I have introduced, an Interagency Council would be tasked to explore these issues and establish all the necessary regulations. In setting standards for each of the degradable processes, the council would have to take into account two main factors: One, the initiation and rate of degradation under different

biological and environmental conditions, and two, the need to ensure, of course, that their use does not pose a threat to human health and to the environment.

I know that both the Federal Government and private research organizations are doing some work in this area. What I want to do is to pool their cumulative knowledge so we can get a handle on the types of products and compounds which are degradable and environmentally safe. Then we can continue to expand the market for degradable plastic products and harvest their full potential.

So I want to particularly welcome our witnesses here today. I look forward to their comments on these and other important concerns.

Senator Kohl?

OPENING STATEMENT OF SENATOR KOHL

Senator KOHL. Thank you, Senator Glenn.

I would like first to commend you on your work on this particular issue. I would like to also take a moment, Senator Glenn, to express my admiration, as well as the admiration of many, many millions of Americans who over the years have admired you for your role as a public servant.

Before I came to Congress you were a role model to me for what a fine and a great American should be, and I think there is no more appropriate time for me to express this to you than today, which is the occasion of your birthday. So I wish you happy birthday.

Chairman GLENN. Thank you very much. I am doing my best to forget them at this point, I think. I told Annie this morning that the last one I really looked forward to was my 21st. It has been downhill since then.

Thank you, Herb, I appreciate that.

Senator KOHL. I would very much like to stay to hear from this impressive list of witnesses myself, but I am also due at an Aging Committee hearing this morning. But I would like to thank all the witnesses who are appearing here for sharing their insights into this important issue with our Committee.

We in Washington are spending a great deal of time this year talking about global environmental issues. We have in no uncertain terms pointed fingers at other countries, suggesting that they act responsibly with regard to their environmental policies. By doing so, we seem to be under the impression that the United States is the shining star, the guiding light in environmental protection.

When is it going to occur to us that we are no role model, that in a global test of environmental responsibility America would fail? Each American produces about 5 pounds of garbage a day—that is a billion pounds of trash made everyday in America. We are only lucky that other countries have not followed our example.

This morning we are talking about a promising technology, a way to reduce the overwhelming presence of plastic in our crowded landfills. We are suggesting that America recognize its own waste management problems, and for that I commend our chairman.

This bill is a good one. Until plastic recycling is firmly underway, or until the collective will of this country decides that plastic, itself, is an unacceptable form of waste, we have little choice but to encourage degradable plastics. This bill will do so. It will also, not incidentally, provide a tremendous new market for a product that American farmers are very good at growing—corn.

As the Committee considers this legislation, I would hope that we could take into account another element in this equation, namely, consumer education. Take this milk jug. I only know that it is made with cornstarch because the National Corn Growers Association tells me that it is. But if it had a big "Made With Cornstarch," or "Biodegradable" label on it, I think consumers might choose it over a nondegradable jug.

Consumer awareness is the only way we are going to eventually tackle our waste management problem, and all of us in the business—industry, consumer groups, the Federal Government—bear some responsibility for that education. I am not sure whether mandatory labeling is a good idea, or whether we should simply encourage degradable labeling, but consumer education needs to be addressed—on plastics, specifically, and on waste reduction generally.

I look forward to working with my colleagues and our Chairman on this Committee to make that happen.

Thank you, Mr. Chairman.

Chairman GLENN. Thank you very much, Senator Kohl.

There are three basic parts of this act—encouragement of development and use of commodity based plastics, the development of standards, definitions and testing methods for degradable plastic products, and an assessment of what food additives do to products like these.

Before we proceed, Senator Carl Levin was not able to be here for the opening. I have a note that he may be along later, but he wanted me to put an opening statement in the record. We will include it at the start of the record as though it was delivered during the opening round. Senator Roth has also submitted a statement for the record that will be included at the same place in the record.

[The opening statements of Senators Levin and Roth follow:]

OPENING STATEMENT OF SENATOR LEVIN

As the crisis of solid waste management has worsened, greater demands are being placed on the federal government to assume a bigger role in solving the problems. To date, however, the federal government has been slow to act.

This hearing is one attempt to get the federal government to play a more active role in solid waste management issues, by establishing federal responsibilities in the area of degradable plastics. I commend Senator Glenn for his leadership on this matter and for holding this hearing today.

The bill before us, S. 1237, which Senator Glenn introduced, asks the federal government to do essentially two things. First, it asks the government to develop standards and testing procedures for degradable plastics. Currently, there are no federal regulations for these plastics. There are no rules which specify, for example, how quickly and completely a product must decompose before it can be considered "degradable" and how benign an effect the residues must have on human health before the product can be considered environmentally safe. There are also no guidelines on how the physical characteristics of degradable plastics must be integrated with landfill management techniques—how to make sure, for example, that photodegradable plastics see the light of day and that biodegradable plastics encounter the microbes necessary for their decomposition. Development of these standards pose many difficult technical and policy questions. At the same time, they are essential to guide

public and private procurement decisions towards environmentally safe and fully degradable plastics.

Second, the bill provides federal support in helping to create a market for degradable plastics made from agricultural products, by setting up a government-wide purchasing preference for these items. This preference would encourage production of environmentally safe degradable plastics; increase markets for agricultural commodities by encouraging a non-food use for them; and possibly reduce American reliance on foreign oil by encouraging production of plastics that don't require petroleum. If this purchasing preference can increase agricultural markets while protecting the environment and reducing our reliance on foreign oil, we're being offered a package deal that we shouldn't pass up.

Developing standards to promote environmentally sound degradable plastics and creating a market for these products are worthwhile activities. They reflect the type of leadership that the federal government can and must show to help ease the crisis in solid waste mangement.

Encouraging degradable plastics will not, of course, solve the entire solid waste management crisis—plastics comprise only about one-tenth of the solid waste stream. Yet plastics production is expected to increase 40% to 50% by the year 2000, they are a known source of litter and damage to wildlife, and they present difficult disposal questions. Thus, we have an issue that deserves our immediate attention.

I am interested to hear the agencies' analysis of the proposed legislation. I also want to hear what the private sector thinks. One witness here today, the Michigan Biotechnology Institute, is one of the leading research institutions in America on degradable plastics. It is working to develop industrial processes which will allow corn-based plastics to experience 100% degradation into environmentally safe elements. This research underlies the technology needed to produce environmentally safe, degradable plastic products such as garbage bags and food packaging. It is a fine example of the businesses we want operating in the future—ones which combine environmental concerns and industrial productivity to produce good jobs and beneficial products—products which will help solve rather than worsen our waste management problems. I look forward to hearing from this Institute, which has been a great asset to the State of Michigan, as well as from all of the other witnesses here today.

OPENING STATEMENT OF SENATOR ROTH

Thank you, Mr. Chairman. I would like to commend you for your continued commitment to the issue of pollution control, and I am pleased that you are holding these hearings in order to give further insight into possible solutions to this problem. As plastics represent an ever-growing portion of the nation's trash, I agree with you that the emerging technologies behind degradable plastics should be thoroughly explored. Degradable plastics could prove to be an important part of a comprehensive strategy to reduce our waste.

Degradable plastics have shown a great deal of promise in the past. Mr. Chairman, I think the uniform standards and definitions for degradable plastics called for in your legislation are important steps in the development of these products and should be carefully pursued. Similarly, the environmental and health consequences of degradable plastics must be fully explored. Furthermore, their effectiveness under certain circumstances must be looked at. Obviously, we have just begun to delve into the potential of degradable plastics as a pollution-control technology.

I would particularly like to applaud our witnesses today from private industry for their hard work in the area of commodity-based degradables. In September of last year this Committee held hearings on this same issue and heard compelling testimony from a number of private sector witnesses, including Delaware's ICI Americas Corporation. I am confident that today's witnesses will offer similar insight, and I look forward to their testimony.

I think we agree, Mr. Chairman, that degradable plastics are not the answer in and of themselves to the nation's waste problems. But combined with a continued plastics recycling effort, better landfill management, citizen education efforts, and the development of product alternatives, we can effectively meet the challenge of pollution and trash.

Thank you, Mr. Chairman.

Chairman GLENN. We have as our first witness this morning, Joan Harn, Analyst, Oceans and Environment Programs, Office of Technology Assessment, OTA.

Joan, we welcome you this morning. We know you have done a lot of work and have a long interest in this area, and we look forward to your testimony this morning. Thank you.

TESTIMONY OF JOAN G. HARN, ANALYST, OCEANS AND ENVIRONMENT PROGRAMS, OFFICE OF TECHNOLOGY ASSESSMENT [1]

Ms. HARN. Thank you, Mr. Chairman. I am honored to be here today.

My name is Joan Harn, and I am an analyst at the Office of Technology Assessment and have worked on degradable plastics as part of OTA's study on municipal solid waste, or trash.

OTA concluded that the main concerns about trash stem from a decline in landfill capacity, health and environmental problems associated with poorly operating facilities, rising management costs, and a general consensus that more recycling and perhaps less generation of trash are possible.

I will focus my testimony on how degradable plastics relates to the major concerns of declining landfill capacity and increasing recycling, as well as the need for uniform standards, definitions and testing methods.

Two major methods have been suggested to save landfill space. One is to increase degradation within landfills, and the other is to keep materials out of landfills in the first place. First, degradation is a source of the environmental health and safety problems at landfills. Unless it can be shown that degradable plastics will degrade into environmentally safe byproducts, nondegradable plastic may cause fewer environmental risks at landfills.

Also, there is now evidence that degradation rates in landfills are very slow for all materials, thus degradable plastics may provide few actual benefits in terms of saving landfill space.

Diverting materials away from landfills through activities such as composting yard wastes, which make up roughly 20 percent of the trash entering landfills nationwide, has the potential for saving space in some areas. If a decision is made to divert yard wastes, degradable plastic bags may be preferable to nondegradable ones for collection, provided degradation products are environmentally safe.

Now I will talk about degradable plastics and recycling. OTA identified three factors that limit the expansion of post-consumer plastics recycling. First, the low rate of collection; second, the lack of technologies for separating different plastic types; and third, the lack of performance standards and testing methods to assure fabricators that recycled resins are of sufficient quality to meet their needs.

It is not clear whether degradable plastics may adversely effect the emerging post-consumer plastics recycling industry. The problems associated with separation and quality are keys to the controversy about degradable plastics and recycling.

The plastics industry contends that degradable plastics might threaten the physical integrity of recycled plastic products and reverse current increases in the recycling of plastics. Technical ex-

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[1] See p. 63 for Ms. Harn's prepared statement.

perts who work with degradable plastics disagree. They contend that if there really are adverse effects, countermeasures can be taken. Further research is needed to resolve this controversy.

Now I will talk about definitions, performance standards and testing methods. Currently there are no agreed upon standards or definitions for degradable plastics. Questions about the rate and timing of degradation in different environments and about the environmental safety of byproducts of degradation either have not been addressed or the research to answer them is only now underway.

The environmental concern is over the size of initial fragments that result from degradation and what will happen next, whether the material will ultimately degrade into inert, dust-sized particles, intermediate organic chemicals, or eventually into carbon dioxide and water.

The fate of additives incorporated into degradable plastic products is also a concern. Additives are extremely important in creating plastic materials with specific properties. For example, lead and cadmium are used to color many resins. Unfortunately there is little information on the fate of these substances when plastic products, whether degradable or nondegradable, become part of the municipal solid waste stream.

ASTM is currently working to develop definitions, performance standards, and uniform testing methods for degradable plastics. This effort will help solve some of the problems I have discussed. However, more work will be necessary to establish a viable Government procurement program for degradable plastics made from agricultural commodities, as called for in S. 1237.

Government procurement programs for such products will confront many of the same difficulties as procurement programs for recycled products. In particular, guidelines will be needed to define and verify the amount of agricultural commodities used in such plastics.

In developing standards, the council established by S. 1237 needs to consider several factors; one, the composition of products qualifying for the procurement program; two, the effect of degradable plastics on recycling efforts; and three, the environmental fate of resins and all additives when any product is disposed of in landfills, incinerated, or thrown away as litter.

To ensure environmental safety, consideration needs to be given not just to the degradable plastic, itself, but also to any additives that might be included when plastic products are made. Such additives currently are regulated only in some cases.

In summary, the expanded use of degradable plastics for solving municipal solid waste problems is questionable until the uncertainties about what happens to them when they are landfilled, incinerated, or mixed with nondegradable materials for recycling are answered. Long term acceptance of degradable plastics will be related to how these products perform, not just as useful products, but also when they are discarded.

At the same time, however, the use of agricultural commodities in general deserves closer attention in product design and trash management. One role which appears promising is the use of degradable plastic bags for collecting yard wastes.

In addition, making plastics degradable is not the only way that agricultural commodities can help with trash management. For example, newly developed starch adhesives may improve the quality of recycled soda bottles and help reduce commercial packaging used in shipping these bottles.

S. 1237 would establish much of the framework needed to evaluate and fulfill the true potential of degradable plastic products.

To close, I would like to commend you for your efforts to develop nonfood uses for agricultural products to solve some difficult environmental problems. Thank you.

Chairman GLENN. Thank you very much, Ms. Harn. We appreciate that. I should have mentioned in introducing you that you are an analyst with the Office of Technology Assessment and have done extensive work in the municipal solid waste field and recently completed a study that discusses the role of degradable plastics in this area as well as the need for uniform standards. You have just completed a study on that which fits right into our hearing today.

OTA has recently conducted a series of workshops on the solid waste management problem. Can you give us some of the findings of these workshops?

Ms. HARN. Mr. Chairman, an interim summary has been released on the OTA report that I can make available to you and your staff.

Chairman GLENN. We would appreciate that.

Ms. HARN. And if you are interested in that, we could even include it as part of the hearing record.[1]

Chairman GLENN. One of the criticisms of degradable plastics is the potential impact on recycling. Are there any research efforts or feasibility studies on recycling degradable products?

Ms. HARN. I am not familiar with any ongoing research associated with recycling degradable plastics, although some of the companies that are producing these materials, claim that some products can be recycled themselves. I think one of the issues is how the degradable plastics would impact other nondegradable plastics which are currently being recycled.

Chairman GLENN. What is the effect on that? Can you mix biodegradable plastics with other plastics that are being recycled? Is that a problem?

Ms. HARN. The plastics industry contends that would create a problem and it may result in the premature degradation of the recycled plastic products. Other experts who are working with degradable plastics say that if you take into consideration the type of plastic product that you are making, that maybe there would be no problem, and even if there was a problem, compensating measures could be taken.

Another way of avoiding the problem would be to separate the degradable plastics from the materials that are going to be recycled, and this could be done through a labeling process. However, the lack of separation technologies is one of the factors that currently is limiting plastics recycling.

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[1] See p. 194.

Most separation of plastics is now being done manually. Research is underway to refine automated methods of separation, but I am not aware of any research to separate nondegradables from degradables through these processes.

Chairman GLENN. Some of the States and localities are using—you mentioned the system of coding or identifying these—some states and localities are using a system of coding various types of household and yard wastes. It seems to me that a degradable plastic garbage bag would be a natural for use in this type of system.

What is going on with the coding and, in particular, for high use items we all see out along the street everyday? Are they being used in this way? What are your thoughts on this?

Ms. HARN. A labeling program for plastic containers is being established voluntarily by the plastics industry. I know that in some of the municipalities where they are experimenting with the use of degradable plastic bags to collect yard waste, they are coloring them in an easily identifiable way so that people know that yard waste is in those bags.

Again the question comes up, what is it that is being used to color these materials? In the case of the Lincoln, Nebraska experiment, their first year bags were colored with cadmium, and they were concerned as to what was going to happen to the cadmium when that material disintegrated and was composted. This year's bags, I don't know what color they are, but they are not being colored with cadmium.

Chairman GLENN. Is there any standard we could set on that? In other words, if I walk into a hardware store to buy whatever it is I am going to buy that is plastic, do you think it is possible to set a standard so we would know just from glancing at a package what is biodegradable and what is not?

Ms. HARN. I think there is probably a great deal of potential for labeling in that area.

Chairman GLENN. Right now we just have to read the label, I guess.

Ms. HARN. Well, I think the label that you are reading is an advertising type label and it is still not clear to people what the degradation really means. It is not clear what the material will degrade into, and that may be of concern in the future.

Chairman GLENN. What percent of solid waste is composed of plastics, do you know?

Ms. HARN. About 7 percent of the municipal solid wastes is plastics.

Chairman GLENN. That is a sizable amount then, in that case.

Ms. HARN. That is by weight, Mr. Chairman. The volume is probably two to three times as great as that.

Chairman GLENN. By weight, 7 percent by weight.

Ms. HARN. Right, and they do not close landfills because they weigh too much, they close landfills because there is too much material going into them.

Chairman GLENN. Too much volume.

Ms. HARN. Right.

Chairman GLENN. And I would think things like these jugs and containers here that have a considerable volume would degrade

down into practically nothing if they went down into their particular elements.

What percent of conventional plastics on the market today are being recycled?

Ms. HARN. It is only about 1 percent of the post-consumer plastics that are now being recycled. This amount is growing considerably, and that result is in part because many of the major resin producers and waste management companies are now getting into the business.

Chairman GLENN. Is it commercially feasible to recycle? If it is only 1 percent, are we doing it mainly for demonstration purposes and concern about developing techniques, or is it really commercially feasible now to recycle plastics and use them over again?

Ms. HARN. Most of the recycling that is occurring now is done for containers made from two resin types, as in PET soda bottles and HDPE milk jugs. In the United States there is also a small scale effort to recycle mixed plastics, foam polystyrene, and research is underway on polyvinyl chloride.

At this point in time, the least amount of effort has gone into recycling plastic films. Now, for the most part, the value of recycled plastics is much higher than the value of other materials that are being recycled, such as glass and paper.

Chairman GLENN. Have there been any problems for food uses of the biodegradable plastics? In other words, it is one thing to have a bag that you put out the garbage in; the main concern there is that there isn't something that reacts with the bag and dumps the whole bottom out.

It is another thing though, on whether if I had milk in this type container or some other drink, as to whether the milk or drink react in any new way with a polymer base that is put into this container along with the plastic, or the biodegradable material that is put in, has some reaction with particular acids or whatever in food.

Who checks out things like that? Does the industry check this out to make sure that we are not creating a problem instead of solving one, or does FDA check that out, or should someone?

Who has the responsibility for that?

Ms. HARN. The Food and Drug Administration would have responsibility for certifying that these materials are acceptable for their standards.

Chairman GLENN. Well, are they doing it at a satisfactory rate?

Ms. HARN. I believe they must respond to a request, an application from industry, for a particular material to be reviewed. And it is the industry that does the testing, that provides information to FDA for them to make their decision.

Chairman GLENN. Well, the reason I asked about FDA in particular is that a number of articles we have come across indicate that Canada is producing and marketing biodegradable products at a level much higher than we are in this country. In fact, it is my understanding that Health and Welfare, Canada, which is the Canadian counterpart of our FDA, has already approved using degradable cups in place of plastic ones and so on. They are moving ahead of us in this regard. So that is the reason I asked whether we are moving fast enough or not.

Ms. HARN. I am not familiar with the difference in the requirements that the Canadian agency has compared with FDA.

Chairman GLENN. Those who claim that degradable plastics could interfere with recycling, we are talking here about 1 percent of 7 percent of the total solid waste, is that right?

Ms. HARN. That is right.

Chairman GLENN. That is pretty small. Are these two ideas mutually exclusive, do you think?

Ms. HARN. I don't think that they are necessarily mutually exclusive, but there are still some unanswered questions and technology development that would be necessary before you could make a definitive answer in that area.

Chairman GLENN. As I mentioned in my opening statement and as we ran into last year when we had hearings on this same subject, there are some obstacles in just developing standards for degradables so we'll know what rules and regulations would apply.

What do you see as the major obstacles to developing standards for degradables?

Ms. HARN. I would suggest two concerns. One is the concern about changing technologies. Some biodegradable technologies, such as those that use a much higher percentage of starch than the ones that are currently commercially available are still in the development stage, and you probably wouldn't want to exclude these approaches by having very limiting standards.

Another issue is the variety of conditions that these materials might be exposed to during their useful life, and also during disposal. Understanding what happens under a variety of environmental conditions may be difficult and time consuming.

Chairman GLENN. Some have said that the degradable plastics, rather than help our litter problem, might exacerbate it, that if more people know an item will eventually degrade, they will throw it away anywhere instead of searching for a trash can.

What do you think of that idea? Do you think that is a possibility?

Ms. HARN. That is certainly one of the viewpoints that you hear in this area. I think at this point you have to consider that only a very small portion of trash is thrown away improperly as litter and it is certainly a higher percentage for some products than for others, although I have not actually seen statistics that say what is that that is being thrown away. Plastic litter is certainly very visible.

The question becomes, when you make these products degradable, what happens to the degradable materials when they are thrown away properly, which is the majority of the materials, and what happens if the degradables are recycled.

Chairman GLENN. What is your view of the status of research in this area? Are we doing enough in this area, or has OTA made any recommendations on expanding or accelerating the research effort? Should there be a greater Federal role? Is industry doing enough? Can you give us some advice in that area?

Ms. HARN. I think most of the research on new products of any type is concerned with the performance during their useful life. Little attention has been given to what happens once you discard the material, and it is only recently, with the increasing concerns

about how and where products are going to be disposed of and the environmental safety of the disposal methods that we have, that this is a concern that has become important to address.

So I think in general there is going to be more of a push towards looking at the whole life cycle of products from the time that materials are first made, what environmental problems are created during manufacture, how the products perform during their useful life, and then what happens to them when they are discarded.

As far as the Federal role, I think the ASTM efforts are likely to be adequate for defining the actual performance of the degradable plastic materials, but as I mentioned in my testimony, additional Federal involvement may be needed to meet the needs of a procurement program to be able to verify the content of the biodegradable material.

Chairman GLENN. That is sort of the track we took here last year, of course, and are still on now, that there is enough research going on and our major effort from a Government standpoint should be to help get us over that first step of introduction into the marketplace. We could do that by encouraging GSA, which is the major buyer for the Government, of course, give them a little incentive to go ahead and purchase some of these new materials so that we would provide a basis for expansion there and in the regular civilian marketplace.

But I am not certain. I do have my own doubts as to whether enough is really being done in this area of research. Now, we have tried to get additional funds through earmarked to do research over in the Department of Agriculture.

Do you think there are other Government agencies that should be involved from your experience looking at this? Should we be getting other research organizations into the act to make it more feasible for everyone, Government and civilians alike?

Ms. HARN. I think the way S. 1237 is constructed is laudable in that it identifies the Government agencies that do have the capability to look into this area, including EPA, National Institute of Standards and Technology, and FDA. And I would like to commend you and your staff for the modification of the provisions of S. 1237 compared with the previous bill that you had introduced on this subject in responding to the concerns that were raised in your hearings last fall.

Chairman GLENN. Good, thank you. I'll just wind down with a couple of last questions here.

Is there any evidence that the degradability process or that currently degradable plastics like these examples on the desk here, do any harm to the environment, themselves?

Ms. HARN. In the marine environment there is now some concern that you may be substituting a problem of entanglement of marine mammals for problems that may be associated with ingesting small plastic fragments. People don't know if that is a problem, but scientists are asking that question now.

Chairman GLENN. In other words, a step beyond the degrading that occurs, then whatever is left, whatever the minute particles would be, marine life would ingest those?

Ms. HARN. They would start eating those thinking that it was food, and what would that impact be? That is a question that the

scientists that are concerned with persistent marine debris are now looking at.

Chairman GLENN. When these things degrade, what size will the residue be? Is it not almost like dust, or what is it?

Ms. HARN. I think eventually it gets to be a dust-sized particle, from most of the claims that I have seen. The question is how long does it take to get there and what happens in the process of getting there. And then, also, what is environmental fate and effect of those dust sized particles.

Chairman GLENN. Let me ask one really off the wall, and this was not on our prepared list of questions, but I have been interested in some comments that there is bacteria that will work on these oil slicks, such as the recert *Valdez* wreck up in Alaska, or the leak that occurred in Prince George's Sound, and that this bacteria will work on crude oil.

If you have ever been around crude oil, that is about as messy and sticky and anything can get once it has been out there for awhile. If bacteria can be used to degrade that, I think they can degrade about anything else. And with the idea that our plastics base comes from petroleum products anyway, I wonder, has anyone looked into bioengineering little bugs of one kind or another that will help degrade this and have them specifically oriented to something like this?

Now, that may sound a bit far out. Are we to the point yet where we can tailor our degradability or increase our degradability by bioengineering the microbes or whatever that will deal with certain types of plastic?

They seem to be able to do that with oil now. If they can do it with something as slushy, gooey and mucky as crude oil, can we do it with this?

Ms. HARN. In some of the discussions that I have had with the researchers at USDA Peoria Lab who are working on degradable plastics, and also at the National Institute of Standards and Technology, they have had a tough time finding organisms that are capable of degrading these biodegradable starch filled plastics.

Where they have been successful in finding them is digging around the back of an old service station in an environment where there is oil, and they have found organisms that will, in a laboratory setting, degrade the plastics products very rapidly; so there is the start of finding the bug that will do the job.

Chairman GLENN. We have not really been successful yet in bioengineering these, nature has been developing these on its own, I guess, is that right?

Ms. HARN. I guess so, but that isn't to say that we cannot then culture those organisms to do it and perhaps to increase that degradation, by increasing the presence of organisms of that type in a landfill.

Chairman GLENN. Well, I hope someone is looking into this. I don't want to have to put into the bill something that would encourage us to go out and dig around the back of stations all over the country, but it is encouraging anyway, that we have something that looks like it is adaptable enough that has been occurring on its own.

If we can accelerate that process and maybe try and reengineer it in this direction a little bit, it might be very productive.

Thank you. Is there anything else you want to add this morning?

Ms. HARN. No, thank you, I appreciate the opportunity to be here.

Chairman GLENN. Thank you, we appreciate it very much. It has been very interesting and we will be continually in touch with you, I am sure, because we want to follow-up on this.

So thank you very much for your testimony, it was excellent. And you will provide us that other study, right?

Ms. HARN. Yes, I would be happy to.

Chairman GLENN. Fine, thank you.

We have a panel now of Federal Government agencies.

James L. DeProspero, Assistant Commissioner for Commodity Management, Federal Supply Service of GSA, General Services Administration; Mr. Bruce Weddle, Acting Director, Municipal Solid Waste Program, Office of Solid Waste, EPA, Environmental Protection Agency; Lyle Schwartz, Director, Institute for Materials, Science and Engineering, National Institute of Standards and Technology; and Mr. Lloyd Robert Lake, Director, Office of Compliance, Food and Drug Administration.

Gentlemen, we welcome your testimony this morning. I don't know how long all of your statements are but if you could summarize them, we will put the whole statements in the record, so we will have time for discussion. If you could give us a summary of your statements we would appreciate that. In either event, your entire statements will be included in the record.

Mr. DeProspero, if you will proceed we would appreciate it.

TESTIMONY OF JAMES L. DePROSPERO, JR., ASSISTANT COMMISSIONER FOR COMMODITY MANAGEMENT, FEDERAL SUPPLY SERVICE, GENERAL SERVICES ADMINISTRATION,[1] ACCOMPANIED BY HAROLD MURRELL, DIRECTOR, OFFICE AND PAPER PRODUCTS COMMODITY CENTER

Mr. DEPROSPERO. I am accompanied today by Harold Murrell, who is the Director of our Office and Paper Products Commodity Center from New York.

We agree that uniform definitions, standards for performance, and testing for performance, safety and health be developed and agreed upon prior to attempting to undertake a major procurement program for degradable plastic products.

We continue to believe, as stated in our previous testimony in the 100th Congress, that a procurement program which promotes the use of degradable plastics could be implemented within existing statutory authority, and, therefore, we oppose S. 1237.

Of major concern is the use of a single award competitive procurement procedure, as described in this bill, using a complicated sliding scale evaluation technique. The single award competitive procurement process works well for established commercial products, but it could be a real deterrent to the commercialization of

[1] See p. 78 for Mr. DeProspero's prepared statement.

existing degradable plastic products and to the development of new degradable plastic products.

Single award competitive procurement often results in a winner take all situation with the Government business door closed to other potential suppliers trying to establish both commercial and Government markets.

Another competitive procurement process, the multiple award schedule, could be used that has some significant pluses for this situation. A multiple award would eliminate the need for complicated sliding scale evaluation and would allow all interested and acceptable suppliers of degradable plastic products to simultaneously seek Federal Government business and obtain the benefits of this business to the establishment of competitive products, and would eliminate the probable lengthy process of identifying products in the GSA system that could be supplied degradable, as the procurement would be left open to all.

To be the source for products for Government users, GSA must be competitive. To undertake a social minded program such as proposed by S. 1237 could well put our industrial funding program in jeopardy of revenue losses due to users switching from GSA to commercial sources.

We have been doing some work in the area of attempting to procure degradable plastic bags during the past year. I would like to briefly relate these recent GSA contract efforts as a possible indication of the state of the industry for this type of product, certainly a leader in the use of degradable technology.

For about a year, we have been vigorously pursuing a program to encourage manufacturers and suppliers of degradable plastic bags to apply to offer their products to Federal activities through the GSA Federal Supply Service's New Item Introductory Schedule, and we call that the NIIS.

This program allows suppliers of new improved products an opportunity to negotiate and obtain a contract with GSA to supply their products directly to Federal activities through the NIIS. The NIIS is a specialized multiple award schedule thereby permitting potentially all acceptable suppliers of degradable plastic bags to have contracts and to seek Government business.

In January of 1989 we mailed letters to 122 firms manufacturing or supplying plastic bags, as well as to firms involved with degradable plastic bags, encouraging them to apply to the NIIS to supply degradable plastic bags. To date we have received only five applications, and we have made award to one manufacturer and are looking forward to additional awards in the near future.

We believe the response to our efforts illustrates the state of the degradable plastic industry, and that is that the available technology has not been translated in any large way to marketable products.

GSA believes whether mandated by statute or not, that it would be more appropriate for the first chairman of the interagency council to be from a technical activity rather than from GSA because of the research and development expertise required.

Further, we want to emphasize that 2 years is too short a period in which to develop a standard.

Under the existing conditions of emerging technology and new product development, the most viable procurement method is the multiple award schedule.

In view of the above, we can not support the enactment of the bill.

Mr. Chairman, this concludes my statement and Harold and I would be glad to answer any questions.

Chairman GLENN. Fine, thank you. We will hold questions until we have everyone's testimony.

Mr. Weddle, you will be next. Mr. Weddle is with the EPA, Environmental Protection Agency.

TESTIMONY OF BRUCE WEDDLE, ACTING DIRECTOR, MUNICIPAL SOLID WASTE PROGRAM, ENVIRONMENTAL PROTECTION AGENCY [1]

Mr. WEDDLE. Good morning, Mr. Chairman, thank you for inviting us today.

I welcome the opportunity to appear before you this morning to provide comments on S. 1237, and I will summarize my comments rather than read the entire statement.

We all know about the size and the complexity of the municipal solid waste problem in this country so I will not dwell on that.

In February of this year, we published "The Solid Waste Dilemma, an Agenda for Action," which is a document that suggests activities for State government, local government, industry and EPA to address the municipal solid waste problem.

That document includes a waste management hierarchy, a hierarchy of alternatives that local governments should look at in solving their own solid waste problems. The first element of that hierarchy is source reduction. We suggest that there is a need to reverse the trend of producing more and more solid waste per person each year. In fact, today the United States produces more waste per person than any country in the world.

The second element of the hierarchy is recycling. We established a 25 percent goal. Today we recycle about 10 percent of our waste. By 1992 we would like to see that increased to 25 percent. The third and fourth elements of the hierarchy, lower in priority, would be a combination of incineration or landfilling.

In the area of recycling, the document identifies Federal procurement as an important if not essential way to stimulate the development of markets.

Federal, State and local governments account for nearly 20 percent of the GNP through their procurements. EPA supports the use of the Federal procurement process to encourage recycling and to develop markets. Recently there have been a number of activities that show the power of that. I would like to compliment GSA. They recently revised 193 paper specifications to eliminate biases toward virgin materials in the procurement of paper by the Federal Government.

GPO in its latest quarterly paper procurement, was able to purchase paper with recycled content in nearly all of the elements

[1] See p. 91 for Mr. Weddle's prepared statement.

that they went to bid on, even though that required a price preference in certain cases. Therefore, as a general matter, EPA supports the bill's approach to stimulating the marketplace through Federal procurement.

Moving to plastics, specifically, we have all seen the graphic pictures of marine life choking or entangled in plastics. Litter on beaches is composed of 50 to 68 percent plastic articles. In some of the harbor studies have shown that 69 percent to virtually all materials are plastic items.

Clearly, plastics are a problem if not recycled or disposed of properly. Therefore, if plastics could be made to degrade quickly and safely in a variety of environmental settings, we would have an ideal solution to this problem.

In looking at your bill, I would like to use the agenda for action to evaluate whether today's degradable plastics are indeed the solution to this problem. And I would like to start with the hierarchy I just mentioned.

First is source reduction. If cornstarch replaced the more toxic additive in the plastic, that would indeed be source reduction. To my knowledge, that is not the case, that it replaces inert filler in plastics. Further, in some cases, additional plastic may be necessary to increase the strength that is lost by using the cornstarch.

So at best I think source reduction is a neutral. There is no gain by using biodegradable bags in source reduction.

In recycling, a previous witness from OTA indicated that there may be some concerns about interference with recycling technology and the quality of the end product in the plastics area. In Greensboro, North Carolina, the city had to discontinue using biodegradable plastic bags because it compromised the end product quality from a polyethylene bag recycling program that was in place there. So there are, indeed, concerns about the impact that biodegradable plastics would have on recycling.

In incinerators, we have not been able to determine any difference between incinerating plastics that are biodegradable or photodegradable and other plastics. And in a landfill environment, we also do not see much advantage. Professor Rathje at the University of Arizona has conducted research that shows that there is very little degradation over a 20 year period in many landfills. Food items like hot dogs are still recognizable 15 to 20 years later, so that any benefits that we would get through the degradation of biodegradable plastics may not be realized until long after the landfill is closed.

So I think that at least the initial reaction that biodegradable plastic would help us with our landfill capacity problem may indeed be overstated.

Beyond the hierarchy there are a number of other serious questions. The questions are, will the bio and photodegradable plastics work quickly in different environments? Will they work in cold marine environments? Will they work in deep shade? Will they work in sunlight? How well do they work? How long does it take?

There are questions about the by-products of that degradation. Will the stabilizers and pigments used in those plastics become more available?

And then there are questions about wildlife ingestion of the plastics that remain, particularly the intermediate sized particles that result as the sheets breakdown into smaller particles. There are certainly questions in this area.

For all of these reasons, EPA believes this bill is premature.

What I would like to do next is summarize what EPA is doing in this area. First, there is a report to Congress on plastics that should be completed by late next month. It will include information on plastics, quantity, production levels, trends. It will talk about the types and sources of marine pollution of plastics and their effects. It will discuss the current state of plastic recycling. It will talk about degradable plastics and echo many of the comments that I am making today.

The second project is a literature search being done by our Office of Research and Development to look at information on the effectiveness of degradables in various environments and to take a look at the testing methods that exist in that area. That project will be completed this fall.

The results of that project will feed into two other projects that we recently decided to fund. The first of those is the conduct of laboratory simulation of the effectiveness of degradables in a variety of environmental settings. We will be exposing degradables of various sorts to fresh water and salt water at various depths, in various lighting and temperature regimes.

We will be looking at the effects of degradation in soils, direct sunlight, shade and so forth. That information will then give us information on how well they degrade in various environments. But we will also be looking at the by-products of that degradation, where did the stabilizers and pigments go? Are they a problem? What are the concentrations?

It will be 12 to 15 months before that information begins to become available. After the completion of that information, we plan to look further at the marine ingestion to see if indeed it is a problem.

The second project that we decided to fund looks at the impact of biodegradables on recycling technology. We will be looking at does it affect the process of recycling? How does it affect it?

We will be looking at the impact on the quality of the product. We will be looking at ways to solve the problems that we find, if we find any of those problems.

It will be roughly a year before we get results.

Hopefully these projects, coupled with efforts that the industry must undertake to evaluate its own products, and the effectiveness of those products, will provide many of the necessary answers. And perhaps they will be able to lead us to further technology development that can overcome any of the problems that we find.

In conclusion, while I have not expressed support for the bill at this time, I am hopeful that degradable plastics will indeed provide a solution to the plastics problem. Therefore, EPA supports the overall goals of the bill. We support the use of the procurement process to stimulate markets and recycling. We believe it is premature, however, to mandate or encourage increased reliance on degradable plastics at this time.

The bill contains important ideas to consider. We will be happy to work with you, the Committee, and your staff as we work through a number of the projects that we are developing.

Thank you, Mr. Chairman. That concludes my statement. I will be glad to take any comments and questions.

Chairman GLENN. Thank you, Mr. Weddle. Just one comment while I think of it at the moment.

The different things you indicate you are doing, can those be run parallel, or do they have to be done in series?

Mr. WEDDLE. They can be run in parallel. In fact, most of them are, and it would be possible for the marine ingestion program to be accelerated.

One of the things we are doing now in finalizing the report to Congress is evaluating our own research programs in plastics as a whole and looking at whether we should redirect funds from other activities or within the plastics area to areas that would be of higher priority and importance.

Chairman GLENN. Because obviously the studies that you are talking about doing, some that are underway now, are things we would like to have the answers to just as fast as possible to guide all of us. Do you have a sufficient funding now to run the programs?

Mr. WEDDLE. We are going to start funding those with money from this fiscal year, and that will be added to next fiscal year's funds. We are also looking at adding additional funds next fiscal year into this area. I can't say right now how much will be available, but we are making those discussions at the deputy administrator level within the agency.

Chairman GLENN. But you do have money available right now to start the program now without waiting until the end of this fiscal year?

Mr. WEDDLE. Yes, that is correct.

Chairman GLENN. Good.

Mr. Schwartz, who is with the National Institute of Standards and Technology, welcome.

TESTIMONY OF LYLE H. SCHWARTZ, PH.D., DIRECTOR, INSTITUTE FOR MATERIALS, SCIENCE AND ENGINEERING, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY,[1] ACCOMPANIED BY LESLIE SMITH, PH.D., CHIEF, POLYMERS DIVISION

Dr. SCHWARTZ. Good morning, Mr. Chairman. With me today is Dr. Leslie Smith, Chief of the Polymers Division at NIST.

I am here to summarize the views of the Department of Commerce with regard to S. 1237. And in the interest of economy of time I will delete some of my remarks and read selectively.

Chairman GLENN. Your entire statement will be included in the record, thank you.

Dr. SCHWARTZ. The concept of plastics which will degrade much more rapidly when exposed to the environment is certainly worth considering. Up to this time, however, we agree with the earlier statements that there has been little research performed on the

[1] See p. 109 for Dr. Schwartz's prepared statement.

various issues associated with the production, use and disposal of degradable plastics.

One method of creating biodegradable plastics is by adding cornstarch to polymers. In one patented process starch is added to petroleum based polymers at levels of 7 to 15 percent by volume. The U.S. Department of Agriculture has developed a process in which 40 to 60 percent starch is added to polyethylene, plus a complex chemical. Films produced by this latter technique have been reported to be transparent, flexible and self supporting.

In an entirely different process, more complex polymers can be created which are degradable by bacteria such as penicillin strains.

In order to develop and make use of degradable plastics, much more research remains to be done on the properties of the plastic, the degradation mechanism and the degradation products. Standard test procedures must be developed. Such standard tests will require knowledge regarding the type of degradation and, in the case of biodegradation, the type of microorganisms to be used; that is marine, fresh water, soil.

Also the composition and the shape of test specimens, testing conditions, for example exposure time, temperature, composition of the test medium, and definitions and measurements of the degradation itself.

Other degradation methods, such as photodegradation, will require similar test development. NIST scientists are currently conducting a modest program aimed at identifying the critical issues in the biodegradation of starch, polymer, plastics in air. The reproducibility of biodegradation test procedures involving a standard mix of fungi developed through ASTM is being studied using well characterized materials supplied by the Department of Agriculture.

NIST scientists are also working closely with ASTM Subcommittee D20.96 on environmentally degradable plastics. NIST has also acted as a consultant to EPA and NOAA, assisting in the preparation of reports on degradable plastics.

At this time we have insufficient knowledge of the mechanisms of plastics degradation and the possible effects of the degradation products on the environment to be able to write effective standards. More research is needed to determine the kinds of test procedures that will be required, both for photodegradable as well as biodegradable plastics.

It will not be possible to develop standards in the 24 months indicated in S. 1237. It typically requires 3 to 5 years for standards to be developed through organizations such as ASTM, even with technologies more mature than this one. Until such time as more is known regarding possible environmental hazards of the degradation products, we believe that requiring Federal agencies to increase the use of degradable plastics is not advisable.

In addition, more information will be needed to make decisions regarding the choice of biodegradable or photodegradable material for a particular application.

In summary, before any action, including this legislation, is taken, regarding increased governmental purchase of degradable plastics, industry should demonstrate that these materials do not pose an environmental risk or interfere with efforts to recycle certain plastics.

At the same time, research into the use of biodegradable plastics should be expanded. The Federal research effort should be coordinated through the Federal Government with the ultimate goal being the generation of measurements standards which, if the materials appear useful, can be employed to aid in their utilization.

Thank you, Mr. Chairman. I will be happy to address any question.

Chairman GLENN. Thank you very much. We will save those until we get to everyone.

Mr. Robert Lake, Lloyd Robert Lake, Director, Office of Compliance, FDA, Food and Drug Administration. Mr. Lake.

TESTIMONY OF LLOYD ROBERT LAKE, DIRECTOR, OFFICE OF COMPLIANCE, FOOD AND DRUG ADMINISTRATION [1]

Mr. LAKE. Good morning, Mr. Chairman. I consider it an honor to be here. I will try to summarize my testimony.

FDA agrees that the disposal of solid waste is a national problem and laud efforts to develop solutions. Numerous solutions to the management of plastic waste, in particular, are being explored, such as recycling, degradability, and even incorporating food packaging as part of the foods themselves to be consumed.

Because of the diversity of polymers and their uses, a variety of solutions may be appropriate and viable. What is important is that various efforts be integrated into an overall solid waste management strategy that deals with all aspects of the solid waste problem effectively. We support EPA's agenda for action that proposes such an integrated solid waste management strategy.

FDA is committed to environmental protection and, within its purview, acts to minimize and avoid negative environmental impacts which result from products it regulates.

In accordance with the National Environmental Policy Act of 1969, NEPA environmental impact consideration has become an integral part of FDA's regulatory process, including our evaluation of food packaging. Based on our assessment, FDA determines whether an action will have significant environmental effects and will require the preparation of an environmental impact statement.

I will defer to the other agencies here to discuss the merits of the associated environmental issues. I will confine the remainder of my remarks to FDA's food additive concerns regarding degradable plastics technology as it relates to packaging.

First, let me discuss a little bit about our food additive provisions. Under Section 201(s) of the Federal Food, Drug and Cosmetic Act, a food additive is defined in part as any substance the intended use of which results or may reasonably be expected to result directly or indirectly in its becoming a component or otherwise affecting the characteristics of any food, including any substance intended for producing, preparing, trading, packaging, transporting or holding food.

Under Section 409(b) of the Food, Drug and Cosmetic Act, any person may file a petition proposing the issuance of a regulation describing the conditions for which a food additive may be safely

[1] See p. 117 for Mr. Lake's prepared statement.

use. The food additive petition must include the additive's identity, the amount of the food additive proposed for use, and the purposes for which it is proposed, its functional effect, a description of the methods used to determine the amount of the additive in the food—which for food packaging means how much migrates from the packaging into food—reports of investigations made regarding the additive's safety, proposed tolerances for the additive, if necessary, and an environmental assessment.

Some examples of direct food additives include things such as calcium silicate, used as an anticaking agent, or Aspartame, a well known sweetener.

Indirect additives include polyethylene, cellophane, and nylon resins which are used to make food packages. Indirect additives are those that become components of food because of their migration or the migration of their components from food contact surfaces.

Food additive petitions are submitted to FDA's Center for Food Safety and Applied Nutrition. After administrative and scientific evaluation of a petition and supporting data, FDA will publish in the Federal Register a regulation prescribing safe conditions of use for the food additive.

Now let me just touch on some of our concerns with regard to the bill. S. 1237 would require FDA to perform an assessment of the safety of food additives intended to increase the degradability of plastic food packaging materials. However, there is currently a lack of very basic information underlying this technology which is critical to a safety review.

It is essential to know the identities of the substances which may be added to plastic in order to make it degradable, their toxicological significance to humans, and how these substances affect polymers in order to impart degradability.

Product characteristics which would need to be evaluated include the comparable long term integrity of the package, whether it might be susceptible to bacteria or fungal growth, and the potential for migration of the substance from food packaged to the food within.

Normally, FDA's role in the food additive petition process is to perform an independent, objective review of the data submitted by sponsors on the safety of additives and their effect on the environment. In the absence of a sponsor, however, our role could perhaps be enhanced to include advising industry on directions of research, to resolve our concerns, or with greater expenditure of resources funding the necessary research.

However, our credibility as a scientific agency depends on our being unbiased reviewers and not advocates for any particular technology or material. Therefore, I must clarify that FDA's position in any research on this technology will not compromise our objectivity in subsequent safety evaluation of products of the technology.

I must also stress that any enhanced role for FDA will require reconsideration of current resource allocations. Various financing options would need to be developed within the administration and discussed with Congress at the appropriate time. Otherwise, FDA would have to divert resources from concurrent petition review activities, thus slowing down decision-making.

I would be happy to answer any questions, thank you.

Chairman GLENN. Thank you very much.

I have several very basic questions. First, am I correct that FDA has not approved any of these biodegradable products yet for food use? I mean not for food use, but as food containers?

Mr. LAKE. That is correct, and to my knowledge we have not actually received any petition as of this time. And as I tried to summarize in my testimony, that is really the way it works, the petitioner comes to us and says, all right, here is a new formulation for food packaging. We have literally hundreds of these on the books where industry have come to us over the years and petitioned for, we have evaluated, and at the end of our evaluation we issue a regulation. As of this time, petitions for these sorts of plastics have not been submitted to the agency.

Chairman GLENN. Now, as far as where there is no contact with food, you don't get into the approval of those? For instance, shopping bags, things like that?

Mr. LAKE. No, we would not be involved in that unless there is a significant food contact.

Chairman GLENN. Now, who does that? Mr. Schwartz do you get into that area? Who gets into that? Mr. DeProspero? Mr. Weddle?

Do we not have to have approval of shopping bags, things like that, that are nonfood contact items? Okay, because they are being used now.

Of course, we have had examples of those and, in fact, some companies have advertised specifically they are using shopping bags that are biodegradable.

Do any of you have doubts about whether we should even permit that kind of use or not at this point? Some of you are for some of the proposals we are making here, some are obviously very much against them, and I am wondering, do you have sufficient doubt about this whole idea that you would even prefer to prohibit, at least for now, even the use of biodegradable shopping bags?

Mr. LAKE. If I may, I would simply not see that as an FDA issue so we would defer it to the EPA or the others.

Chairman GLENN. Okay, who would like to pick that up? We have eliminated one.

Mr. WEDDLE. The only thing I have heard that would suggest that that would be an appropriate course of action is some of the environmental groups are very concerned, particularly Environmental Action Foundation, about the adverse impact that this could have on recycling programs. They are very concerned because plastic recycling is something that is growing very rapidly now.

Clearly, plastic bags are not recycled now and they are probably much lower in the hierarchy of what will be recycled first, and I don't think there is a basis to ban it now. But, clearly, there are concerns being evidenced by some of the environmental groups about it.

Chairman GLENN. Yes.

Mr. SCHWARTZ. Well, I would make one comment, and that is the issues that have been raised with regard to the coloring additives in these materials. If the bags that are used can be certified to have no heavy metals such as lead and cadmium in them for color-

ing, then their complete biodegradability, if that were in fact to take place in a landfill, would be of no issue.

If, however, those metals were then released into the landfill, one would have to worry about their possible ultimate escape into the environment.

Chairman GLENN. Well, we have some companies out there right now that are pushing their products, trying to make more sales in this area with the biodegradable plastics. And we have supported that because we, from all the testimony we have had, thought it was good.

It was a matter of pushing this a little bit, getting some Government buying through GSA, Mr. DeProspero, to help over this initial hump of getting this introduced into the marketplace, which the Government could do. And that was the tack that we took on this.

I am not getting very good answers here as to whether you feel it is safe to even go ahead with that at this point, but what we were trying to do was expand that use, at least, while FDA and others do additional testing, as you have indicated.

We thought at least that the present use was certainly proven and worthy of support and we wanted to push that, so we at least get the industry going and let them generate some funds, especially generate some more research funds, and new products that we could all be certain would eventually be safe.

Now, that is the tact we are taking with this particular bill. So I am still operating on that theory unless someone is willing to come forward and say no, it is not even safe to do what we are doing now.

Mr. WEDDLE. Maybe I can address that a little bit. Philosophically, one could proceed to encourage and require the use of a product until it is shown not to be safe; one could proceed to allow a product to be used until it is shown not to be safe; and one could ban the use of a product until it is shown to be safe.

EPA is suggesting that the first of those three is not appropriate, that we shouldn't be requiring the Federal Government to procure something until we show that it is safe. EPA is in the second box; and that is we are not opposed to the product being marketed. We would like to see it developed in a very safe way, we would like to evaluate it; but we are not prepared to support mandatory requirements for the Federal Government to purchase it.

The third category would be something I would put food products into. You don't want to use those until they are proved to be safe. That clearly isn't the situation here.

So EPA would be in the middle box.

Mr. DEPROSPERO. From GSA's point of view, while we are using the multiple award schedule program we depend entirely upon manufacturers, upon their test results, so that we are not defining the product and we are not putting out any specification, any technical documents that they must meet. We use their certifications and their test procedures concerning the product.

Chairman GLENN. Mr. DeProspero, last year you testified for GSA that what we needed was a small scale pilot program in this area, and I have taken your suggestions into account. We modified

the bill this year. I believe it is workable and it would meet your definition of a small scale pilot program.

As I understand it, you now state that even this type of program is unnecessary, you have in-house authority to begin degradable procurement.

Have you had a change of view on this? Would your in-house programs offer incentives to make up any cost differentials, which is one of the things we wanted to help get this established in the marketplace. And what methods will you use to determine increased need or demand for degradable items?

Let's start on that. Have you had a change of view since last year?

Mr. DEPROSPERO. Well, we think that the multiple award program would be the way to do it, because what happens here is if you go to single procurement, you eliminate everybody but the one person that got the contract, so essentially——

Chairman GLENN. Well, I don't believe that we had a requirement that there be just one contractor. I think you could competitively bid this thing and have a dozen contractors, if they were there. That is one of the good things about it, I thought, that we were going to encourage more people to get involved in this.

Mr. DEPROSPERO. Well, that is what we have done already with the multiple award program.

Chairman GLENN. Why do you refer then to the single contract, why that?

Mr. MURRELL. Senator Glenn, I am Harold Murrell, I am the Director of the Commodity Center in New York, office supplies and paper products.

What Mr. DeProspero is concerned with is that in establishing a standard for competitive procurements, our concern is, No. 1, that the standard be understood by the industrial base that bids on our procurements and that it can be complied with and that a sufficient number of bidders will in fact bid to insure a reasonable price.

I think the testimony this morning has indicated that industry is not at that level yet that we can lock in on one technological approach and incorporate that into a technical document which would then become the standard held out to all bidders in competitive procurements.

Chairman GLENN. Well, why would this bill prevent that? I thought that is exactly what we were trying to do. We want to get more competition in this. We want to encourage more companies into it. I don't understand the comment about single contractor.

Mr. DEPROSPERO. Well, what I am trying to say is that the more contractors we have under contract, the more product selections we users have which is the way we have gone now. We already have one contractor for a multiple award and we have five other offers that we are looking at currently, but we don't mandate to them how they are to manufacture the product or the percent of the degradable compounds, et cetera.

So by industry contractors doing their own research, we are not limiting anybody from progressing in the field. And, I think that is what we are trying to do—that is, to promote as many con-

tractors, as many manufacturers to pursue their own avenues, and we are willing to give them a contract based on that.

Chairman GLENN. Do you add any incentives to make up cost differentials?

Mr. DEPROSPERO. Not on the multiple award. You mean like your bill proposes that we supplement?

Chairman GLENN. Yes.

Mr. DEPROSPERO. No, sir. We feel that the way that would occur was something similar to what you had talked about earlier—that is, denoting on the product that it is biodegradable—getting our agencies to go ahead and procure that product because of its degradable capabilities rather than trying to supplement it with some type of procurement program.

Chairman GLENN. Do we buy any of these products from Canada at this point?

Mr. MURRELL. At this point on the award that we made, Senator, no. The additive that our particular contractor adds to his product he is obtaining from a domestic firm.

Chairman GLENN. Okay. Have we had Canadians bid on any of these contracts?

Mr. MURRELL. No, sir.

Chairman GLENN. Because the Canadians are apparently ahead of us in this area. I have here an advertisement in a catalog for a biodegradable trash bag. The secret is cornstarch, it says, and it is a Canadian company which is supplying it.

Mr. DEPROSPERO. There is nothing in the bill as I read it that would preclude that from happening.

Chairman GLENN. With our trade situation with Canada now, the Canadians can well bid on this, on these contracts with GSA, can they not?

Mr. DEPROSPERO. Yes.

Chairman GLENN. And would we be disposed to, no matter what their clearance for their product was, would we be willing to accept their bid on any—is there any reason why we would not consider their bid if they were competitive?

Mr. DEPROSPERO. No, we would certainly consider it and negotiate with them.

Chairman GLENN. Have you proceeded with a pilot program that we talked about last year using degradable plastics in the GSA inventory?

Mr. DEPROSPERO. We have proceeded with the multiple award schedule program, yes, sir, and that is the one I said we already have a contract on.

Chairman GLENN. Multiple award schedule program.

Mr. DEPROSPERO. Yes, that is correct.

Chairman GLENN. Define that for me again, please.

Mr. DEPROSPERO. Well, what that amounts to is that we have a program where more than one manufacturer may get a contract with GSA. And in the plastic bag arena, for instance, we are optimistic that we will have as many as five firms that would have a contract with us, that agencies could buy from any one of those firms, and their products. And we are currently negotiating with several firms for that product and we have made an award to one contractor at this time.

Chairman GLENN. Are the biodegradable products price competitive now without having an incentive granted them?

Mr. MURRELL. The preliminary indications, certainly based on this first contract that we have awarded, is that the prices are in some cases considerably higher than nondegradable plastic bags.

Chairman GLENN. You don't let them be used for any food use; is that correct?

Mr. MURRELL. The contract that we have awarded are for different sizes of trash bags.

Chairman GLENN. These are trash bags only, so far.

Mr. MURRELL. Yes, sir.

Chairman GLENN. Not food containers or things like that.

Mr. MURRELL. That is correct, sir.

Chairman GLENN. And you would wait until you got FDA, got approval from Mr. Lake over here, before you went ahead with that?

Mr. MURRELL. Yes, sir.

Chairman GLENN. Mr. Weddle, I believe you felt that your research indicates that degradable plastics will not help much with source reduction, waste volume, recycling incineration, or landfill waste management.

In view of your limited research results, what data are you using to validate these assertions, because it would seem to me they would benefit in those areas?

Mr. WEDDLE. Okay, let me do it in reverse order. As I mentioned, Professor Rathje's work shows that there is little degradation in a landfill of even some things that would be highly degradable, like food products. So based on that it is certainly intuitive that if you have a plastic that has a cornstarch base for degradation, that that would be handled the same way so that there would be little degradation there.

An incinerator, again it is intuitive, there is no research here, but there is no reason to believe that a plastic bag that has cornstarch in it would act any differently than a plastic bag that did not when combusted in the incinerator.

In the area of recycling, it is basically anecdotal information. The Greensboro situation that I talked about, discussions with environmental groups have indicated that it is a fairly widespread concern on the part of people who recycle plastics that it may interfere with product quality or with the recycling process, but I don't have any specific research that I can lean toward there, and that is one of the reasons why we are funding the project that I announced this morning.

And in source reduction, we define source reduction as reducing the amount of waste produced with degradable plastics the volume of the bag is roughly the same as other plastic bags. We also define source reduction as reducing the toxicity of the product. Therefore, it would be source reduction if one replaces the cornstarch with something that was not as toxic, and I don't think that is happening.

And source reduction would be producing something that lasts longer. I don't think that is an issue for the degradable bags either. So that definition of source reduction doesn't apply.

That is not to say that there might not be good applications for degradable bags. Ms. Harn mentioned collecting compostable materials in biodegradable bags, and some of the agricultural films use might make sense. The issues there would be more of what are the by-products of the degradation and do they compromise the compost, and there is literally no information in that area at all.

Chairman GLENN. Mr. DeProspero, as I understand it, you don't favor even trying to set standards now; is that correct?

Mr. DEPROSPERO. No, what I am saying is that I think one of the scientific activities should do that rather than GSA. The bill has GSA heading up that activity. I believe that that is necessary, absolutely, but I don't believe it should be GSA's role. I think it would be more appropriate in one of the——

Chairman GLENN. You think it is appropriate at this particular time in the development of this whole thing to go ahead and set standards as best we can right now, but you just don't see GSA as being the lead agency in that?

Mr. DEPROSPERO. That is correct.

Chairman GLENN. Okay. Thank you gentlemen. We may have additional questions that we want to submit to you.

We would appreciate your early response to those and thank you for being here this morning. Thank you.

On our next panel this morning we were scheduled originally to have Mr. Joseph O'Grady, President of the American Society for Testing and Materials. He was unable to be here. He is being replaced by the Executive Vice President, Mr. James Thomas, accompanied by Ramani Narayan, Researcher, Laboratory of Renewable Resources Engineering, Purdue University of West Lafayette, Indiana.

Also with us is Jerry Petak, Business Development Manager, Archer Daniels Midland Company of Decatur, Illinois; and Mr. Jack Pincus, Vice President for Economic Development, Michigan Biotechnology Institute, Lansing, Michigan.

Gentlemen, welcome this morning and we look forward to your testimony. If your statements are lengthy, we would prefer a summarized version and the entire statement will be included in the record. In either event the statement will be included.

Mr. Thomas, I know you replaced Mr. O'Grady. Welcome this morning, and if you can lead off, we would appreciate it.

TESTIMONY OF JAMES THOMAS, EXECUTIVE VICE PRESIDENT, AMERICAN SOCIETY FOR TESTING AND MATERIALS, PHILADELPHIA, PA,[1] ACCOMPANIED BY RAMANI NARAYAN, PH.D., RESEARCHER, LABORATORY OF RENEWABLE RESOURCES ENGINEERING, PURDUE UNIVERSITY, WEST LAFAYETTE, IN [2]

Mr. THOMAS. I would like to first thank you for giving ASTM an opportunity to be here. ASTM, formally known as the American Society for Testing and Materials, is one of the leading standards organizations in the world for the development of voluntary consensus standards, materials, products, systems and services.

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[1] See p. 131 for the statement of Joseph G. O'Grady, president of ASTM.
[2] See p. 156 for Dr. Narayan's prepared statement.

Its 134 standards writing committees publish some 8,500 standards annually. These standards meet needs of industry, Government, academia, testing agencies, and the service sectors of our economy. ASTM committees cover a wide spectrum of subjects, which include ferrous and nonferrous metals, ceramics, waste disposal, plastics, construction materials, petroleum, textiles, fire standards, medical services, biotechnology, and consumer products.

These standards are in many instances the preferred document for trade. Since its formation in 1898, ASTM has expanded to include some 32,000 members, of which over 4,500 are international.

ASTM is a management system for standards development that serves both private and public interests. It is a system that works well, is not dominated by any single interest group, and it is one of the best examples of Government and non-Government sectors working together.

Although ASTM, a nonprofit society, cannot support nor oppose legislative initiatives, we do appreciate and support the sense of Senate Bill 1237 as it addresses a fundamental and critical environmental problem. We must also refrain from scientific or administrative judgments concerning the efficacy of the proposals contained in this bill. We will, therefore, limit our comments to those portions of the bill that concern the development of standards and testing procedures.

ASTM Committee D20 on plastics has been addressing standards needs for the plastic industry for over 50 years. It has developed close to 400 standards and has 750 volunteer members. ASTM Subcommittee D20.96 on environmentally degradable plastics was formally organized on March 15, 1989. Attached to this testimony are the minutes of their initial meetings and some other general information regarding their activities.

The scope of this subcommittee is the promotion of knowledge and the development of standards for plastics which are intended to environmentally degrade. There are four sections in D20.96 which deal with the different classifications of degradability. They are biodegradable, photodegradable, chemical degradable, and environmental fate, which is working to establish standard procedures for determining the byproducts of degradation and their fate in the environment. In addition a section has also been formed to address the terminology issues.

This subcommittee on environmentally degradable plastics in its five sections are comprised of members representing the plastics industry, various Government agencies, including EPA, USDA, U.S. Army, the NIST, U.S. Navy, and the GSA. Academia is represented, as well as agricultural organizations such as the National Corn Growers Association, Iowa Corn Promotion Board, and the Corn Growers of North Carolina.

As you can see, many of the Government agencies who comprise the proposed interagency council have representatives already involved in the ASTM standards setting process. If it were determined that ASTM should have input into the interagency council in some sort of consultative capacity, we would be pleased to appoint an appropriate person to be available for meetings, to give updates on the activities of our Subcommittee D20.96, and to render whatever appropriate services are requested.

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I cannot leave this Committee, however, without making the following point. The sovereignty of Government in certain areas is a principle ASTM has always respected and upheld. Responsibility in matters of health, safety, the environment, and the organization and structure of departments is clearly a matter of public management and authority.

Our history is full of collaborations with that sovereignty for the good of the American people. There are instances too numerous to mention of Government initiatives supported by the technical resources of the voluntary consensus standards system.

We cannot leave you in good conscience without offering it to you now in an area where it excels, the development of definitions, standards, and testing procedures. We therefore ask you to consider the benefits of a standards developing system that is capable of absorbing all interested Government agencies, of adding the wealth of collective technical and practical wisdom from the others that must be partners in the result, of providing the administration a prudent, transparent, and rigorous management which will present in the end a balanced result, both in science and in social aspects.

We suggest to you that it is significantly easier to implement a practice that has inherent in it the experience and the loyalties of those who will be directly affected.

I would like to thank you, Senator, for holding a hearing on such an important topic. I sincerely hope that the work and experience of ASTM will be of some benefit to you, the Committee, and to the successful resolution of a problem that is so vital to the health of this planet.

I would be happy to answer questions, and if we move into any areas requiring technical background, Dr. Narayan also serves as the chairman of our Subcommittee D20.96, and he will be able to provide some additional support.

Chairman GLENN. Dr. Narayan, do you have a statement?

Dr. NARAYAN. Yes.

Chairman GLENN. We would like to have that at this time, please.

Dr. NARAYAN. I would like to make these statements more as a researcher who has worked in the area of polymers, plastics, as well as happening to chair ASTM D20.96.

I appreciate very much your invitation to appear as a witness and testify on bill S. 1237, the Degradable Commodity Plastics Procurement and Standards Act of 1989. The bill recognizes an opportunity to address critical issues facing the Nation; (A) the growing environmental problems associated with the use of ever growing disposable plastics, (B) the vitality and even the continued sustainability of our Nation's agricultural system.

As specified in the bill, the development of new nonfood uses, like disposable plastics packaging for agricultural commodities, will reduce crop surpluses, raise farm income, and lower the cost of agricultural subsidies provided by the Federal Government.

However, another impact area of the bill that has not been brought out in that bill is the contribution biodegradable plastics could make to the sustainability of the agricultural system itself. The composting of degradable plastic waste, which could include lawn, yard and other degradable waste, would provide much

needed carbon rich soil for our depleted top soils. This will be discussed in greater detail later to show the impact which could be made in this area as well.

The equally important energy issue, which presently has been relegated to the back burner, will be benefited by implementation of the bill. The use of our own agricultural resources in plastics as a substitute in part, or even completely, would reduce the use of foreign oil, which is the base for all these synthetic plastics.

While not going into too much detail on the energy issue, let me just point out that in 1987 alone the United States paid foreign countries nearly $40 billion for oil, that is totaling 23 percent of our record high trade deficits.

In this presentation, I will discuss the following. I want to bring out environmental concerns and potential solutions, the solid waste management crisis, and the need for environmentally degradable plastics. I want to introduce the concept of biodegradable plastics and the tremendous misconceptions and myths which exist about them.

Specifically, I want to introduce the concept of composting, and I would like to address the issue of landfills, specifically relating to these much publicized findings of 20, 30 year old degradable materials like paper in landfills which is being used to advocate against biodegradable plastic usage.

I am also going to show the compatibility of degradable plastics technology with both recycling and incineration, which, again, has been mentioned in this hearing as being incompatible with recycling.

I am also going to address the fate and toxicity of these degradable products, which has been made out to be a problem with degradable plastics. Current activities at both the national and international level relating to degradable materials, specifically relating to development of standards, test methods, terminology will be presented and I would like to have my own specific recommendations.

In trying to cover all of these, I am going to summarize some of my major presentation which appears in detail in my prepared statement. The first address I want to make is on environmental concerns. 1987 was a banner year for plastics production. It was a 55 billion pound production in sales.

Packaging accounts for 30 percent of the entire plastics market. It is this area of packaging in consumer goods which is the visible disposable item that is being targeted for the degradable plastics market. The plastic production is expected to be close to 80 billion pounds by the year 2000, and a growing share of this plastics market will be the disposable packaging and consumer goods.

This visible plastic litter, especially packaging items, disposable consumer goods, like bottles, cups, wrappers, six pack ring connectors, grocery sacks, et cetera, scars landscapes, foul beaches, and entangles sea creatures.

Plastic accounts for 31.4 percent by volume in the municipal waste stream, as opposed to the reported 7.3 percent by weight. This is based on an average compacted density of 7 pounds per cubic feet of plastic. The current average landfill cost is $65 per ton and is expected to double by the year 2000. And at the same time

25 percent of major U.S. cities will be out of landfill capacity by the year 1991.

Marine pollution is another major problem. Environmentalists estimate that the amount of plastics dumped into the ocean reaches more than one million tons world-wide per year. Woods Hole Oceanographic Institute reports as many as 45,000 pieces of plastic per square mile at sea. Ten miles of plastic netting from Asian commercial fishing alone are lost everyday.

The U.S. Navy disposes 4 tons of plastics, including 450,000 plastic containers daily into the oceans. OTA reports that tens of thousands of sea birds and an estimated 100,000 marine mammals die each year by ingestion or becoming entangled with plastic debris.

A potential solution which has been advocated for solving this solid waste management problems is: Incineration. Obviously, this permits us to reduce the volume of solid waste generated and converts waste to energy.

However, there are a number of questions and concerns which have been raised and need to be addressed. These are problems of heavy metals, dioxins, acid gases, polynuclear aromatic hydrocarbons, ash disposal, et cetera.

Last but not the least, incineration releases CO_2 with its potential problems of global warming, an issue which has been in the news recently.

Recycling: Recycling has been targeted to be the method of choice for plastic, waste management. Without a doubt recycling is very important but it is only a part of the whole waste management issue. Only 25 percent of plastic waste will be suitable for use. This includes a handful of separable reusable, recyclable packaging systems. For example, a pop bottle—polyethylene terephthalate bottles—or a polyethylene milk jug.

Commingled wastes, especially single use packaging materials like wrappers for example, if you travel in an airplane they give you all these different packages wrapped up in disposable plastics. They are composed of a variety of generic polymer types, not to mention the myriad of additives that goes into it.

These are difficult, if not impossible, to recycle. It has been claimed that commingled scrap waste in its entirety can be recycled to useful products. However, any polymer scientist will recognize that mixing of even two different types of polymer resins, for example, a polystyrene and a polyethylene, will result in a product with very poor properties. And I have illustrated this data from literature [1] which proves this point about the fact that if you have a mixture of different plastics, they cannot be recycled and that you need some other solution for such materials.

Thus, this leaves a very definite role for environmentally degradable plastics in this whole arena of waste management. Clearly, it is not the panacea for the entire waste management problem, but it is one of the solutions which must be used along with recycling and incineration.

Having made a case for the environmentally degradable plastics, I would also like to explain the concept of what we mean by "de-

[1] See prepared statement on p. 156.

gradable plastics" and what we really hope to accomplish with an environmentally degradable plastic.

Biodegradable plastics does not imply that the entire material just completely disappears overnight into CO_2 and water. This is a myth and the biggest misconception over biodegradable plastics. Nothing, not even well known degradable materials like dead plants and leaves, are completely converted into CO_2 and water.

A major part of it is converted into humic material. This is the "compost" material which every one of us is very familiar with in composting our garden wastes. And I have incorporated a figure taken from an ecology textbook which essentially illustrates these concepts and represents the carbon cycle of our natural ecological system.

Without going into too much detail, the concept is that plants fix carbon dioxide by photosynthesis and grow. They then decay, produce dead organic matter. This organic matter is acted upon by microorganisms in the soil, which respire, part of which goes to CO_2 and the rest is converted into organic humic material. This is the carbon enriched soil material which returns almost something like 9,000 carbons per hectare of soil to the agricultural system. And this is a friendly environment for the survival of soil, micro and macro organisms, as well as plants and crops.

So, if you want to talk about the rationale for degradable plastics, then this is it to modify plastics so that they can become a part of nature's recycling system. Unfortunately, plastics, as we know of it today, are not inherently biodegradable and scientists historically have sought ways to make them more resistant to other kinds of degradation as well.

The resistance of plastics to biological degradation is due to a number of reasons. Microorganisms have not yet had time to adapt and synthesize polymer specific enzymes capable of degrading and utilizing these man-made synthetic polymers of recent origin.

The hydrophobic character of the plastics inhibits enzyme activity and the low surface area of the plastics, with it inherent molecular weights compounds this problem further. Furthermore, their strength and durability makes them impervious to accelerated breakdown in the oceans or on land.

Thus, the rationale is to modify this useful and convenient plastics materials so that they can be broken down under environmental conditions to environmentally friendly material, not just to CO_2 and water, but in part to CO_2 and water and part to humic material, which forms the soil.

And obviously, naturally occurring biopolymers, the agricultural resources of our nation, like starch, cellulose, are readily biodegradable and the incorporation of these types of polymers into plastics by blending, by copolymerization, should lead to new types of plastics having the trait of biodegradability. These natural polymers offer the water borne enzyme systems a foot hold on the polymer surface, which induces the biodegradability of it.

To cut this short, let me add that the end products of such a degradation would be humic material, which is what plants and leaves go to, CO_2 and water in a normal aerobic environment. While this is a normal biosynthetic pathway, it needs to be established and

that is why you need to look at the fate of the products of degradation.

Photodegradable plastics can also do the same job and the resultant small molecules can be utilized by microorganisms .

Now, I would like to take time to address the issue of composting and address the problem of this nondegradability in landfills. The timeframes necessary for the natural ecosystems to operate will not be able to cope with the solid wastes we produce, and this includes both the plastic and the naturally degradable lawn, yard waste, paper, et cetera. In fact, it is estimated that one-third of our municipal solid waste stream is lawn and yard waste.

However, currently we pack our degradable lawn and yard waste into nondegradable plastic bags and bury them in landfills which have been designed to be tombs devoid of any moisture and oxygen. As a result, there is no possibility of anything to degrade, leave alone a biodegradable plastic.

We are, in effect, if I may call it so, "preserving garbage for posterity," and this is what today's landfill technology is. We need an accelerated degradation of the wastes so that we can return the materials back to nature and close the materials cycle loop. This leads us to the concept of composting and managing landfills where accelerated degradation can occur. Composting is an accelerated degradation of heterogeneous organic matter by a mixed microbial population in a moist, warm, aerobic environment. This is widely practiced in other countries as a viable waste management approach, as shown.

France, for example, has over 100 plants producing 800,000 tons of compost each year. Sweden composts one quarter of its solid wastes, and Europe is leaning towards composting over incineration. And I have in the prepared statement a conceptual composting scheme wherein one can control and monitor the whole composting operation. By composting our wastes, not only do we solve a solid waste management problem, but another very important issue, and that is the sustainability of our agricultural system.

You must have heard about the problems of top soil erosion, poor water and nutrient retention, sub-optimal plant growth, and, essentially, depletion of our top soil in organic matter. The composted material, the waste which is generated, could be put into a top soil operation and help the sustainability of our agricultural system.

The next issue which has been brought up at these hearings is compatibility with recycling systems. One of the major criticisms leveled at degradable plastics is that they are not compatible with recycling systems. While this may be true of photodegradable materials, the biopolymers—the cornstarch, the cellulose, the natural polymer based degradable plastics—should pose no problem whatsoever in recycling. All that is needed is a simple acid treatment of the waste material which will hydrolyze the biopolymer, leaving behind synthetic resins which are unaffected by the acid. In fact, such a step not only gets rid of the biopolymer, but any metal additives which may be present, leaving a much more purer "virgin" resin for recycling.

We have done preliminary work on the commercial 6 percent starch based plastics and have shown that this starch can be readily removed by acid treatment. I have incorporated in the prepared

statement a figure which denotes how a commingled waste stream which is used in recycling can be made compatible with current recycling processing concepts.

I would now like to talk about the current activities, both at the national and international level, on degradable materials, specifically relating to development of standards, test methods, terminology and classifications. An international conference aimed at reaching a consensus on degradable materials specifically relating to terminology, test methods, degradation case studies and fate of degradation products is being organized in Toronto, Canada, on November 2nd to the 4th. This conference is being sponsored by both the Canadian and U.S. organizations and companies. I am one of the organizers of the conference and would be glad to send details of the conference to this Committee.

Chairman GLENN. We would appreciate those, thank you.

Dr. NARAYAN. ASTM has formally approved the formation of Subcommittee D20.96, which was discussed earlier, titled "Environmentally Degradable Plastics," which I now chair. The scope of the Committee is the promotion of knowledge and the development of standards for plastics which are intended to environmentally degrade. It has been to the surprise of many in ASTM that we have made much headway, and I would like to refer to figure 6, which appears in my last page of the prepared statement, on the status and action items, and would like to go over it in a little detail, because this is one of the major components of this bill.

We have, in trying to come up with an environmentally degradable plastic test procedure, defined a material "X" which has to go through a test environment, and the test environment could be divided as a photodegradable test environment, and on the left-hand side we have identified 3 different test environments. We have identified biodegradable test environments, which will address landfill, sewage, composting, soils and litter. We are also talking about anaerobic environment, which is in the landfill. We also are addressing test environments of aquatic origin—marine and fresh water.

The task groups will come up with actual procedures to identify test environments. Next, properties will be determined, and there are procedures being written up to determine properties after being exposed to these test environments. This will determine percent degradability.

Now, ASTM is a consensus organization, and obviously, all this has to go through approvals from subcommittee down to committee to the final approval levels. We are still at the subcommittee level, but we believe that these documents could be prepared and go through the whole ballot process and we think a very good consensus document on standards, test methods, procedures, would come out of this. And with that I would like to stop and entertain any questions on this.

Chairman GLENN. Thank you very much.

Our next witness is Mr. Jerry Petak, Business Development Manager, Archer Daniels Midland Company, Decatur, Illinois. Mr. Petak, welcome.

TESTIMONY OF JERRY L. PETAK, BUSINESS DEVELOPMENT MANAGER, ARCHER DANIELS MIDLAND CO., DECATUR, IL [1]

Mr. PETAK. Good morning, Mr. Chairman. Thank you for inviting me to comment on S. 1237, the Degradable Commodity Plastics Procurement Act.

Archer Daniels Midland is a manufacturer of agricultural foodstuffs of many types, processing corn, soybeans, wheat, rice, and many other agricultural products. We are a large supplier to the food industry, not only in the United States, but throughout the world, and are always working toward improving and expanding our markets for both food use and nonfood use of agricultural products. This continuing effort to find new nonfood uses for agricultural products is what led us to our current involvement in degradable plastics.

In mid-1987 we obtained the world-wide rights to a process for incorporation of food grade cornstarch into polyethylenes, polystyrenes and polypropylenes, which will enable the producer of those types of products to produce a degradable plastic.

The first products for which we started producing a masterbatch additive were, of course, garbage bags and department store type carry bags. We have been successfully marketing a raw material masterbatch additive, trade named POLYCLEAN, for that market for 14 months. We are currently finalizing our formulations for our masterbatch additive that will serve the high density polyethylene blow molding market, which has provided some of the samples that you have in front of the room of high density blow molded milk containers, oil bottles and so forth. We are also continuing to work in polystyrene foams and rigid polystyrene products as well. None of those products are currently on the marketplace today, as we are in the process of reviewing FDA applications for those products.

The cost of those products depends upon the use and strength requirements by the companies. When we first started producing those products, our costs were in the 30 to 40 percent range increased costs over conventional plastics. During the last year, of course, we have made tremendous improvements in both the way we produce our masterbatch and the producers of films have also learned how to operate the plants much more efficiently and today our costs of producing a degradable film versus a conventional plastic will range anywhere from 5 to 20 percent increase. These numbers are provided by our customers. Since we are not in the polyethylene film business, we rely on those customers to supply us that information.

The demand for degradable products has grown tremendously. Over the last year, our particular customer list has grown from virtually two accounts to approximately 30 accounts, virtually coast to coast.

We have potential customers who are looking at product applications, such as Tampon applicators and so forth, in injection molded applications, which could use as much as 45 percent cornstarch. The products that you have on display range anywhere from 2 per-

[1] See p. 174 for Mr. Petak's prepared statement.

cent to 20 percent cornstarch. The polystyrene foam, for instance, that you have contains approximately 20 percent in the clam shell. The milk bottles will contain 6 percent.

Chairman GLENN. Like this?

Mr. PETAK. Yes.

Senator GLENN. That says 15 percent.

Mr. PETAK. That is the masterbatch additive. We add the masterbatch at 15 percent.

Chairman GLENN. This is what? This one goes up to 20?

Mr. PETAK. Yes. Since we are a large supplier of food ingredients throughout the United States and the world, we are proceeding in a very conservative manner as far as food area applications are concerned. We have a great concern since our initial involvement in this business with developing and maintaining proper standards and guidelines, and, of course, proper definitions for degradable plastics.

When we entered the degradable plastics business, we made the decision to work through the ASTM subcommittee structure to establish proper definitions and terminology for degradable plastics and we are continuing to work through that system.

As could be expected, we have encountered a few situations in the marketplace which have caused us some difficulties because of not having particular definitions established, and therefore are very much interested in a timely finalization of the findings of ASTM. The greatest problem which we have encountered relative to standardization has been that of degradation rates and/or degradable additives content.

It has been our experience that any films that are produced with a starch based degradable additive that does not contain at least 6 percent cornstarch does not degrade as quickly as one would like for it to in many applications which are currently in the marketplace. Since our degradable additive, POLYCLEAN, consists of not only food grade cornstarch but three other proprietary ingredients which react with or without sunlight and with or without moisture, some standardization or a reasonable and demonstrable period of degradation time is essential for proper definitions.

Since our product does work in those particular environments, I would like to mention the comments that have arisen earlier from test results by a Dr. Rathje of landfill digs and so forth finding that no degradation takes place in those environments. I would like to point out that we don't argue with these findings at all. Our only concern is that none of those particular findings have included any of degradable products with our particular formulation, or anyone else's formulation. Therefore, we are anxious to see what future findings do uncover as far as degradation in landfills that do contain these products from the last couple of years forward.

At this point in the marketplace, by far the best application for degradable plastics is in the area of compost bags, which will degrade in a matter of several weeks to a few months, depending upon the ingredients of the compost bag. By utilizing degradable plastic bags in a composting program, several communities are realizing some great savings in the operation of their composting

projects. I have attached in my testimony some particular information pertaining to those programs.[1]

The other applications for degradable plastics are emerging and look very favorable. Certainly the consumer demand is increasing tremendously and as a whole the degradable plastics industry is responding quite well. In the last few months there has been a Degradable Plastics Council formed, which I would be happy to supply you some information on that council if you do not already have it.

Chairman GLENN. I would like to have that, please.

Mr. PETAK. That is made up of companies such as ourselves, producers of a degradable masterbatch additive, as well as film companies, bottle companies, and also consumer related plastics companies.

Addition of degradable plastic additives is really no different than new basic conventional plastics product changes that have taken place over the last 10 or 15 years. We find it is a matter of the production facility learning how best to produce degradable products in their plants. Degradable plastics products can be produced without changing any equipment in most plant operations.

Another issue which I would like to address is the recycling of degradable plastics. We have producers of degradable plastic films and/or bottles who recycle and regrind plastic scrap, which is generated in the manufacturing plant itself. Examples of those types of recycling would be ends of roles of films and flashing from injection molded processes. Degradable plastics of this type can be recycled without any problem, according to our customers.

As far as post-consumer recycling in the area of plastic film, we have information on one experiment conducted with the Reiffenhauser-Van Dorn Company, which is a firm that produces equipment used in the recycling of plastics. We used a POLYCLEAN containing film which was aged for 12 months. It was reprocessed by Riffenhauser-Van Dorn into polyethylene pellets without any production problems whatsoever. The pellets were then used to make polyethylene film which had comparable properties to that of virgin degradable films. It must be remembered that our POLYCLEAN additive, as we state in our process recommendations, has a shelf life of approximately 14 months and can be recycled without problems at least up to the age of 12 months. After that time, we do not have test data which would support a valid recycling effort at this point. Of course, our degradable plastics, in our opinion, would be one which would have served its purpose in 12 to 14 months and this is a type of market that we are addressing, a one time use, if you will, or short lived plastic application.

As a result of the lack of uniform standards and definitions for degradable plastics, early on we discovered that we would have to supply many of the answers relative to degradation and how these products would act in certain environments. We elected to enter into many private evaluations and test procedures which I have outlined in the report submitted to you.

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[1] The information referred to may be found in the Committee files.

The first of these studies is being conducted by the Waste Management Institute, State University of New York at Stony Brook. The scope of the test is to determine degradation rates in landfills, marine tidal pool and fresh water environments. There is also a study being undertaken by the new products group, University of Missouri at Columbia. The scope of that study is to develop test methodology for standard soil burial conditions and to determine the effect of polyethylene residues on soil drainage, fertility and erosion, and to study the degradation of starch containing polymers in compost environments.

We also have a test being conducted by the Hazelton Laboratories in Madison, Wisconsin to evaluate those products which you have represented in front of you for FDA direct food contact extraction tests, and those results should be forthcoming.

We have been experiencing tremendous growth in the marketplace as far as customer application of products. We have seen a lot of product improvement overcoming some of the issues of strength and so forth that we were faced with early on.

In general, the people that have made the commitment to work with this product have been able to produce very acceptable products on a consumer level basis, and those people are experiencing tremendous demand growth for these products and anticipate it to continue right on through.

That is all I have in the way of a prepared statement.

Chairman GLENN. Thank you, Mr. Petak.

Dr. Pincus, Vice President for Economic Development, Michigan Biotechnology Institute, Lansing, Michigan. Dr. Pincus, welcome.

TESTIMONY OF JACK H. PINCUS, PH.D., VICE PRESIDENT FOR ECONOMIC DEVELOPMENT, MICHIGAN BIOTECHNOLOGY INSTITUTE, LANSING, MI [1]

Dr. PINCUS. Thank you, Mr. Chairman, and thank you for the opportunity to appear before the Committee today and submit testimony on biodegradable plastics.

By way of introduction, Michigan Biotechnology Institute, or MBI, is an independent, nonprofit commercially oriented biotechnology center. We are organized along industrial lines and we concentrate solely on industrial biotechnology, or large volume biological processes that are aimed at transforming agricultural commodities such as corn into higher value commercial products. The key to our research is transforming low value agricultural commodities into higher value commercial products manufactured, for example, in the range of 100 million pounds or more a year.

We are unique in that we conduct applied research and scale-up activities combining both biological and engineering expertise to develop technology beyond the laboratory bench. Our goal is to transfer technology to industry for commercialization. At MBI, technology is a tool for economic development. Therefore, our programs are sensitive to market needs. Our research programs fall into three areas: fermentation, industrial enzymes and waste treatment.

What we have heard about this morning are biodegradable plastics that are currently on the market. We consider these first gen-

[1] See p. 183 for Dr. Pincus' prepared statement.

eration plastics. At MBI we are performing research that we believe will lead to second generation biodegradable plastics. We are developing processes that use bacteria and other microorganisms to produce components that will be used to manufacture second generation biodegradable plastics that can be used for disposable plastic bags and industrial food containers.

Our economic projections, based on scenarios of substituting biodegradable materials for nondegradable materials, estimate a total market value for biodegradable plastics of 90 to $600 million year.

Two specific plastics we are working on are polylactides and polyol plastics. Polylactides, or polymers of lactic acid, are known. They are currently used in medical applications. The problem is that they are too expensive for consumer uses. By concentrating on producing the monomer, lactic acid, inexpensively by biological processes, we believe we will be able to produce polylactides that are cost competitive with plastics currently used.

Polylactides and polyols utilize carboxylic acids, or substances derived from them. They provide a more biodegradable base for plastics products than do substances currently on the market. As Dr. Narayan said, biodegradability is a matter of definition. Not everything is totally biodegradable. The products we envision will not contain any petrochemically derived materials but will be organic matter that has the potential to biodegrade.

By looking at lowering the cost of manufacture, we hope that our products will be cost competitive with petroleum based chemicals—our initial analysis indicates they would be—and the carboxylic acids themselves will use renewable resources such as starch in their manufacture.

The provisions in the proposed legislation which promote the development of degradable plastics by offering incentives and increased access to Government markets are excellent ways for the Government to support this emerging technology. However, I would like to stress the importance of supporting the technology development phase as well as the research phase.

If we are to achieve progress in this area, it is crucial that we integrate our research with real commercial processes for manufacturing biodegradable plastics and that these then be transferred to industry. We must not lose the competitive edge in this field by failing to support the commercialization of the technology as aggressively as basic research.

There have been many comments on standards this morning. I would like to say that we are expanding our team. In particular, Dr. Narayan will be joining us in several weeks, and we hope to integrate the development of standards into our research program.

At this time I would like to comment on the timeliness of S. 1237 and on the pressing need for legislation promoting the development of biodegradable plastics. Last week I was in Japan and I met with several representatives from Japanese chemical companies. I was initially surprised that during our discussion the subject of biodegradable plastics emerged as a topic of great interest to the Japanese.

On further discussion, I learned that MITI, the Ministry of International Trade and Industry, is preparing to launch a full scale development program for biodegradable plastics. I have several arti-

cles, one in English,[1] that I would like to introduce into the records, and two in Japanese.[2] I have had these summarized, we intend to have them fully translated and I will be happy to provide the text to you.

Chairman GLENN. I hope you have an English version of that. We would be glad to accept them for the record.

Dr. PINCUS. We will.

The situation in Japan is that space is limited, landfills are not used. They burn plastics. There are environmental considerations and that they don't want to continue burning. They are concerned about switching to paper because it will increase destruction of their forests, and Japan as a nation is not terribly self sufficient in raw materials.

What MITI has done is put together a survey team. They visited the United States. They spoke to researchers in universities. The article says they also visited Archer Daniels Midland. As a result of that, they are preparing to launch a full scale development effort for biodegradable plastics that will be centered at the Bioindustry Society.

They are directing this program to result in practical application of what we consider second generation biodegradable plastics in 3 to 4 years. Their initial investment in the program is $1 million. They expect to put more money in in later years, and they are now positioning themselves to be a major player in new plastics development technology.

Japanese companies I spoke to were very interested in MBI's programs and have asked us if we can submit proposals on biodegradable plastics. Unfortunately their interest does not come as a surprise. Japan pinpointed biotechnology as one of the three key technologies in its future a long time ago, and they have acted on these plans by forming biotechnology consortia involving government, universities and businesses.

As we know, they obtain access to U.S. biotechnology research by either buying into small U.S. firms, purchasing technology, and establishing research labs in the United States, employing American research scientists.

Mr. Chairman, the Japanese are serious about this. They expect to have a product on the market in 3 to 4 years. It will be a second generation product, more biodegradable than the ones we have now. Given their previous history, I am confident that they will achieve this goal. We must act promptly to achieve the same goal.

I would like to conclude by applauding your efforts to support research, development, and commercialization of biodegradable plastics, and I thank you for inviting me to testify. Once again, I am hopeful that through a combined effort we can capitalize on our research in this area and be successful in transferring the benefits of technology to the Nation's agricultural sector and various industries.

I welcome any questions you may have.

Chairman GLENN. Thank you, Dr. Pincus.

Mr. Petak, you support the bill, I presume; is that correct?

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[1] See p. 188.

[2] The two Japanese articles have been retained in the Committee files.

Mr. PETAK. Yes.

Chairman GLENN. And Dr. Narayan?

Dr. NARAYAN. Yes.

Chairman GLENN. And Mr. Thomas, just so we get this all on the record?

Mr. THOMAS. I am not sure if I could say that unequivocally. We support—we are not in a position to take any formal position on the bill. What we would like to do is to provide the system for development of standards in place at ASTM to fulfill that component of the bill that addresses standards, specifications and terminology.

Chairman GLENN. Fine, all right.

Dr. Narayan, from your involvement with other countries currently producing and marketing degradable products, where does the U.S. place in terms of our research and our marketing, from your observation. Are they ahead of us or behind us in this realm?

Dr. NARAYAN. Well, right now all of them are behind us. In fact, I am invited to talk at a carbohydrate conference organized by The Netherlands, France and the European Community scheduled in October of this year. They believe in the same concepts which this bill proposes, and they are promoting not only biodegradable plastics but the whole spectrum of new materials from carbohydrate based sources. They don't use cornstarch, they use potato starch, but it is the same concept.

The Japanese have actually sent letters requesting patent rights to technologies which we have developed, which so far we have not accepted.

Chairman GLENN. Mr. Petak, are you familiar with the City of Greensboro's example cited by the EPA?

Mr. PETAK. No I am not, sir. I am not familiar with it.

Chairman GLENN. Are you, Dr. Narayan, or anyone else here at the table? Where they apparently were into this biodegradable business by collecting different things and handling them in different ways and they gave up on this project. I wondered if any of you had information as to why that occurred.

Dr. NARAYAN. The degradable plastics, in terms of landfills, which is where you bury them and then you come back and you find out whether anything has happened or not happened, is dictated by the environment in which it is buried in. If you bury it in Arizona maybe it will take you forever for it to degrade under the conditions. If it is in Florida, it may happen overnight.

And therefore, we believe that landfills have to be managed or composted if degradable plastics really have to make an inroad into the waste management issues.

Chairman GLENN. Dr. Pincus, I asked a question a while ago of Ms. Harn when she was on earlier, about whether you can see right now that some of this biodegradability and biotechnology can be applied or tailored to specific purposes like this, even as we have a form of biodegradability working on the oil spill up there, the Valdez oil spill.

Do you see now that we might be able to develop specific bugs, as we called them earlier, microbes, molecules, or whatever, that would be a specifically tailored means of dealing with specific types of things we might want to biodegrade?

Dr. PINCUS. Mr. Chairman, in theory that is possible. The question is the effect of introducing new life forms into landfills or composts. We would have to analyze for these effects.

I don't know whether that is absolutely necessary. Dr. Narayan has pointed out composting as an alternative to landfill, and I certainly support that. The City of Lansing, Michigan, gives out biodegradable plastic bags for trash collection and uses those bags in a composting system. The 1 or 1½ years experience so far indicates that that is working satisfactorily.

Chairman GLENN. Do your figures there show what Dr. Narayan also said, that about one-third of the solid waste is lawn and yard wastes? I was surprised at that figure. That is very high.

Dr. PINCUS. Those figures are right.

Chairman GLENN. And does the use of biodegradable bags—the kind that they are using there in Lansing, what time period is required for this to start its action in biodegradability and how long does the composting then take to come to reasonable completion?

Dr. PINCUS. The composting is still going on. Composting is a long term process, but the biodegradation starts immediately. As I said, there is only 1½ years experience so far, but so far the city deems it satisfactory.

Chairman GLENN. Mr. Petak, you indicated your markets are increasing, and you indicated by the way you gave that remark that they are increasing rather rapidly. Are other companies getting in this field?

The reason I ask this is that our original impetus a couple of years ago in putting this legislation together was the idea we needed a push, we needed a drive to get over the hump and make this thing commercially viable.

What you are saying in effect is that maybe we don't need that same kind of push now; is that correct?

Mr. PETAK. No, I still believe we do. There are still only two major companies producing a degradable starch based additive for products. We would still like to see other companies enter the marketplace. We have seen some other starch producing companies begin to show interest in the process, but so far none have entered the marketplace. But we still feel there is that need.

Chairman GLENN. Mr. Thomas, some question whether 2 years is sufficient time to develop standards and definitions. And ASTM committee, D20.96 you referred to, met last week to discuss definitions and standards for degradable products.

Would you discuss the status of those activities and provide us some insight as to how long this will take to accomplish this task? You mentioned in your testimony the bio, the photo, the chemical biodegradable, and one other category, I believe you had there. But how long is it going to take for us to set standards and definitions? Because it seems to me that is rather critical toward encouraging people to get going on this.

Is it going to take another couple of years to set standards and definitions?

Mr. THOMAS. Well, the future is always risky to guess, but last week the committee did meet so I will respond generically and Dr. Narayan may be able to give some specifics of what took place last week.

In ASTM we find that the speed with which a process moves depends on three things, the urgency of the need, the complexity of the technical issues, and the amount of commitment that the volunteers are willing to give to the project. The need, the urgency of the need can be determined by lots of things—the marketplace, regulatory pressures, there could be foreign competition and other things that could drive the need.

The complexity of the technical issues is one that has been addressed several times, and then the commitment of volunteers. We have had, in the very short time of this committee's existence, an extreme amount of interest in the topic. The first meeting attracted over 100 participants to the activity and, from my knowledge, it hasn't diminished to any extent. And they have met now twice, and possibly some further specifics.

Dr. NARAYAN. The interest in this Environmentally Degradable Plastics Subcommittee has been tremendous. Just to cite, the international conference I mentioned has speakers talking on degradable plastics from Exxon, Mobil Chemical, and a couple of more oil companies who will be actually speaking on degradable plastics, which would tend to support the concept that they are looking at all of these pretty seriously. In fact, all my speakers at that international conference are from oil companies.

Chairman GLENN. Do they have any concepts of biodegradability other than the combination with food products or with starch or things like that?

Dr. NARAYAN. I believe that companies, including companies like DuPont, are looking at various types of technologies. This is just a personal observation, and I envision that in the next 2 years you will see a whole area of bio and photodegradable plastics. I believe that the impetus has been driven exclusively by legislation and the requirement that you need such materials. I don't believe that we would have seen this much activity in this area if there had been no such impetus from the Federal Government.

Chairman GLENN. What do you do with all the composting now? Let's say you are composting in Lansing on a very big scale in biodegradable bags. You got that put into a compost now. And we are all familiar with the little compost on the back end of your lot where you use it and reuse it for fertilizer.

Are you using it to that extent there, or what happens once this composts down?

Dr. PINCUS. That is the ultimate intention, to use it for fertilizer. And by analogy, there are several businesses I am familiar with on the east coast where they collect lawn clippings and trash, go through composting, and then produce a fertilizer which is sold commercially.

Chairman GLENN. You can? Do you have to dry it, or what do you do with it? Can you use it straight out of the compost heap?

Dr. PINCUS. As I understand it, they are essentially using it straight out of the compost heap.

Chairman GLENN. Is it a wet type fertilizer, then?

Dr. PINCUS. No, it is dry.

Chairman GLENN. Okay. My time is almost up.

Senator Levin?

Senator LEVIN. Thank you, Mr. Chairman.

I am sorry that I could only join you for a few minutes this morning, given the importance of this hearing.

Chairman GLENN. You walked in appropriately as the man from Michigan started his testimony.

Senator LEVIN. That was not a coincidence. As a matter of fact, I wanted to spend the few minutes that I could with this panel, particularly, because of MBI's presence here. They have been important not just to our State but to the Nation and I am glad to see that they are such strong supporters of your bill, Mr. Chairman. I think it is a very significant initiative and I wanted to be here particularly to welcome Dr. Pincus and to ask just a few questions.

Is it technically possible now to produce an agriculturally based product that is 100 percent degradable? Maybe Dr. Pincus, you could start with that.

Dr. PINCUS. It is technically possible to do it now, Senator, but until recently the costs have been too high. Advances we have made in the production of the monomer over the past year suggest that within the next 2 years these materials can be produced at a cost that is competitive with existing plastics.

Senator LEVIN. I wanted to get into the cost question next, and that is, can you compare them now, costwise, and what do you hope for in the next few years?

Dr. PINCUS. Yes, let's take polylactides as an example. They are used in medicine for sutures and in wound healing. Those cost on the order of several dollars a pound. Polystyrene, if I recall, is of the order of 60 cents a pound. We believe we can bring the cost of polylactides down to the level of cost of polystyrene.

Senator LEVIN. Within what period of time?

Dr. PINCUS. Within 1½ to 2 years.

Senator LEVIN. So that right now there is a significant difference in cost but within 2 to 3 years you expect to be competitive?

Dr. PINCUS. Yes.

Senator LEVIN. And what about the residues? There has been some testimony this morning, apparently, questioning whether the residues of degradable plastics will be safe. Could you and other members of the panel comment on that, if you have not already?

Dr. PINCUS. Most of the testimony this morning, Senator, was directed at the currently used, "biodegradable plastic," which is a mixture of starch and polyethylene. Polylactides, as an example, do not contain any petroleum based derivatives, so they should be more degradable.

Problems in residues left by paints or other materials used in labeling can be solved by using materials that are nontoxic for labeling or printing inks. Polylactides are currently used, as I said, in medical applications, so it is known that their toxicity is minimal to humans.

Senator LEVIN. Does anyone else want to comment on that, on the residue issue?

Dr. NARAYAN. If I may address the toxicity issue. Unfortunately, in creating a degradable plastic, people talked about cellophane which was the first known plastic, even before the synthetics came. They are totally biodegradable. Unfortunately they are made by technology. In fact, the cellophane is used for sausage casings,

which is used to make hotdogs. It is used today in this country. That is a totally biodegradable material.

Unfortunately, it employs technology which is more toxic to make and nobody is making cellophane and therefore you don't have a cellophane bag. But here is an example of a material which is totally biodegradable.

I envision 2 to 3 years down the road products coming out where now we add 6 percent starch to plastics, it would be the other way around in applications where you would add 6 to 8 percent of the synthetic plastic to give it the feel and the texture and the strength of the plastic, but give it 80 percent of the natural polymer base, polylactide is the classic example of where the technology is going.

Senator LEVIN. I understand that when degradable plastics are deposited in landfills that they sometimes don't degrade because the photodegradables are not exposed to sunlight and the biodegradables are not in an environment where the needed microbes develop.

Again, let me start with you, Dr. Pincus, but others can comment. Is it possible to integrate degradable plastic technology with landfill management in order to resolve that problem?

Dr. PINCUS. Yes, it certainly is. In fact, one thing that I neglected to point out in my testimony is that the second generation plastics we are working on also have the potential to be recycled back into the monomer from which they were made, so there are two alternative pathways, burying in landfills or composting, or recycling into the monomer for reuse. We think offering these options will allow the type of integration you are talking about.

Senator LEVIN. And this second generation is biodegradable, not just photodegradable?

Dr. PINCUS. Yes, these are biodegradable.

Senator LEVIN. These are all biodegradable.

Dr. PINCUS. These are biodegradable, yes.

Mr. PETAK. Senator, I would like to comment if I might. In our particular degradable additive system, we not only use food-grade cornstarch but we also combine three other proprietary ingredients which work simultaneously, of course, with the cornstarch, but they will allow degradation with or without moisture and with or without sunlight. In either case they will degrade.

Senator LEVIN. My last question relates to Japan, which, Dr. Pincus, you raised, and I think another witness has also talked about. Japan is moving in this area. Are we ahead of Japan right now in the area of research?

Dr. PINCUS. We are at par with Japan right now, but they are moving fast. And given the resources I believe they intend to put behind this, they could soon be ahead of us.

Senator LEVIN. Now, if they commercialize a degradable plastic first, will it be easy for us and other countries to follow, or will that then be either a patented or protected approach which will give Japan a lead which will put us at a competitive disadvantage?

Dr. PINCUS. Discussions I had last week with people at the American embassy, in particular, several of the commercial counselors, suggest to me that if Japan develops this technology first, they will do it in a way that they own it, they protect it, they control it. And

once that happens, as has been the history with other things the Japanese develop, it might be difficult for us to catch up.

Senator LEVIN. Anybody else want to comment on that?

Thank you, Mr. Chairman.

Chairman GLENN. Thank you very much, Senator Levin.

One last question or area of discussion here. We have been talking about regular plastics with foodstuff additives.

Is there any development on the horizon you see where we would be able to use food products in a way where they become the principal source of these products instead of only the 2 percent, 5 percent, 10 percent?

Are there developments along the cellophane line such as you are talking about where we take something like that which is completely biodegradable, even digestible, and we make that the plastic use norm for bags and so on? Are there developments that look promising along that line?

Dr. NARAYAN. Yes, we work at a university and therefore we don't have a commercial product. My research is supported by the National Science Foundation and by the Department of Energy's Energy Conversion and Utilization Technologies program. As a part of the DOE program, we are essentially working on those lines. We are using—if you recall, cornstarch is made up of 2 types of materials, one is what we call amylose, which is a straight chain polymer, which is essentially similar to the cellulosics, like the cellophane type material.

And we have actually been able to make amylose acetate films, just like you make a cellophane. In fact, in today's plastics they still use cellophane in many of these applications.

But we have been able to make amylose films and we have, in order to give it the strength, incorporated just like you said, just enough synthetic plastic to make it very stable. And that is where I think this technology is headed, where in 2 to 3 years down the road you will see 80 to 90 percent made up of natural polymers, not just cornstarch by itself, but components of the starch or components of lignocellulosics like cellulose, and the addition of synthetic polymers as just as an ally to help build properties into it using processing technologies, which is where we are at the research stage.

Dr. PINCUS. Let me add to what Dr. Narayan said. There is a natural polymer called pullulgn which is a carbohydrate polymer. It is an edible substance in Japan. If it could be made cheaply enough, it could be used as a biodegradable plastic.

Chairman GLENN. Gentlemen, we are going to have to end. I have another commitment and I am a little late for it right now. I was due there at 12 o'clock, as a matter of fact, so we are going to have to end.

I, obviously, am a fan of using Government purchasing power where we can to help move us into some of these fields. We have had pretty good results in other areas in the past; photovoltaics in fuel cells, for example, that were developed and moved, at least in part, by Government support, into more common use.

And that may be where we find ourselves right now in this particular area. I am interested in following up this last area of questioning on the possible use of synthetics that come completely from

the food product chain and are converted into cellophane or similar type products. I don't know whether that still legally incorporates the term of "plastics" or not. Is it called something else?

Dr. NARAYAN. Cellophane is still a plastic.

Chairman GLENN. Cellophane is a plastic whether it is petroleum based or not, I guess.

Dr. NARAYAN. It is. It appears in the plastics journals, so it is a "plastic" by definition.

Chairman GLENN. The fact that it appears in a plastics journal doesn't necessarily make it legit.

Well, thank you very much and we may want to submit additional questions to you. I am sorry we have to end now. It is a fascinating subject and one I think we are going to be getting into more in the future. I want to do whatever we can at this level to help move this thing along, and for two reasons. One, not only the waste product we have problems with in this country, but also as I've said before, to see some research on the nonfood uses of these agricultural products.

I have felt for a long time we needed to do more in that area. ADM has done a lot in the field. I am aware of it. I compliment them for doing that. I think finding new uses, to me—rather than just continually finding ways to produce more—is the way to go and make better use of tremendous capabilities we have.

Thank you all very much. I would appreciate it if you would respond to any additional questions we have, which we will include in the record, and thank you very much for being here this morning.

The hearing will stand in recess subject to the call of the chair.

[Whereupon, at 12:15 p.m., the Committee adjourned, subject to the call of the Chair.]

APPENDIX

101ST CONGRESS
1ST SESSION

S. 1237

To require the Administrator of the General Services Administration to encourage the use of plastics derived from certain commodities, and to include such products in the General Services Administration inventory for supply to Federal agencies, and to establish an Interagency Council on Biodegradable Standards for the development of uniform definitions, standards, and testing procedures for degradable plastic products made from certain commodities, and for other purposes.

IN THE SENATE OF THE UNITED STATES

JUNE 22 (legislative day, JANUARY 3), 1989

Mr. GLENN introduced the following bill; which was read twice and referred to the Committee on Governmental Affairs

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A BILL

To require the Administrator of the General Services Administration to encourage the use of plastics derived from certain commodities, and to include such products in the General Services Administration inventory for supply to Federal agencies, and to establish an Interagency Council on Biodegradable Standards for the development of uniform definitions, standards, and testing procedures for degradable plastic products made from certain commodities, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Degradable Commodity Plastics Procurement and Standards Act of 1989".

SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—Congress finds that—

(1) the achievement of long-term health for the agriculture sector of the United States is essential to the vitality of the national economy, the well-being of our citizens and rural communities, and the maintenance of national security;

(2) the development of new nonfood uses for agricultural commodities will reduce crop surpluses, raise farm income, and lower the cost of agricultural subsidies provided by the Federal Government;

(3) the economic security of the United States requires that the Federal Government should promote the development and use of products derived from agricultural commodities through the preferential procurement of such products to reach a threshold level of commercial application at which such products can successfully compete;

(4) more than one-half of the cities in the United States will exhaust their current landfill capacity by 1990, and the management of this growing volume of solid waste is one of the most urgent and fundamental

environmental problems facing Federal, State, and local officials;

(5) plastic products comprise a significant amount of the 150,000,000 tons of solid waste produced in the United States and the use of degradable plastics products made from agricultural commodities can provide a positive impact in solving the problem of solid waste disposal;

(6) the technology exists to develop and market degradable agricultural commodity-based plastics for use in packaging, agricultural mulching, and in other applications;

(7) the widespread introduction of the technology referred to in paragraph (6) into the commercial marketplace will provide a new outlet for United States agricultural products;

(8) the use of domestically produced agricultural commodity-based degradable plastics products will reduce the reliance of the United States on imported oil and result in an improved trade balance for the United States and increased employment opportunities for our citizens;

(9) the Federal Government should assist in bringing agricultural commodity-based degradable plastics to a level of commercial application comparable to other

alternative products and should provide incentives for the development and adoption of such products;

(10) the potential benefits of degradable plastic products cannot be realized on a commercial scale without the development of uniform standards and testing procedures; and

(11) the adoption of uniform standards and testing procedures will assist Federal, State, and local government officials in developing effective agricultural, environmental, and economic policies.

(b) PURPOSE.—It is the purpose of this Act to provide—

(1) that the Federal Government shall—

(A) promote the continued development of degradable plastics technology by increasing the purchases of degradable plastics products, with special emphasis on agricultural commodity-based products;

(B) assist State and local entities in purchasing degradable plastics products;

(C) provide incentives for further technology development through the preferential procurement of degradable plastics products, with special emphasis on agricultural commodity-based technologies;

(D) promote the manufacture and purchase of degradable plastics products by assisting producers in demonstrating the capability of this technology;

(E) assign agency responsibility for the development of definitions, standards, and testing procedures;

(F) ensure that degradable plastic products meet safety standards for human use, consumption, and environmental concerns;

(G) increase the commercial availability of agricultural commodity-based degradable plastics products;

(H) support existing Federal, State, local, and privately sponsored degradable plastics programs; and

(I) be provided with advice concerning the status of research in new nonfood uses for agricultural commodities; and

(2) for the establishment of an interagency council to develop and coordinate the implementation of this Act.

SEC. 3. DEFINITIONS.

As used in this Act—

(1) AGRICULTURAL COMMODITY-BASED PLASTICS.—The term "agricultural commodity-based plastics" means plastic products that use agricultural commodity products as a constituent component.

(2) DEGRADABLE.—The term "degradable" means the biologically or light induced loss of utilitarian or physical characteristics of a plastic or hybrid material containing plastics as a major component.

(3) GOVERNMENT PURCHASING CATALOG.—The term "government purchasing catalog" means any approved list of items supplied by the General Services Administration to agencies of the Federal Government.

(4) NONFOOD USES FOR AGRICULTURAL COMMODITIES.—The term "nonfood uses for agricultural commodities" means uses for agricultural commodities that do not involve the consumption of the commodities as food.

(5) PREFERENTIAL PROCUREMENT.—The term "preferential procurement" means any procurement practice employed by the Federal Government that gives preference to the selection of an item or service based on any criteria in addition to cost and performance.

(6) SLIDING SCALE RATING METHOD.—The term "sliding scale rating method" means an evaluation

method used in Federal procurement procedures that reduces the cost bid for an item according to an established criteria for purposes of determining the effective low bid.

(7) SOLID WASTE.—The term "solid waste" means nonsewage waste which must be disposed of by Federal, State, or local officials through landfills, incineration, or other approved methods.

SEC. 4. ENCOURAGEMENT OF DEVELOPMENT AND USE OF COMMODITY-BASED PLASTICS.

(a) GENERAL SERVICES ADMINISTRATION.—The Administrator of the General Services Administration (hereinafter referred to in this Act as the "Administrator") shall—

(1) identify products in the General Services Administration government purchasing catalogue or in the inventory of the General Services Administration that can be made from degradable plastics technology, and that are environmentally safe, with particular emphasis on agricultural commodity-based products; and

(2) make available in the standard General Services Administration government purchasing catalogue the products identified above through competitive bidding process as prescribed in subsection (c).

(b) REQUESTS.—On the request of the head of any agency of the Federal Government, the Administrator shall

ensure that such Federal agency be provided with products acquired under this section to the maximum extent practicable.

(c) COMPETITIVE BIDDING.—

(1) SLIDING SCALE.—In awarding competitive bids for the provision of products, the Administrator shall develop and implement a sliding scale rating method for awarding contracts based on such competitive bids for the acquisition of products under subsection (a).

(2) FACTORS.—The sliding scale developed under paragraph (1) shall consider, in addition to price and performance of the offered products, other factors that make the use of degradable plastics technology advantageous, including—

(A) the increased market for agricultural products;

(B) the benefits to the environment; and

(C) the benefits to the long-term energy independence of the United States.

(d) COST OF PRODUCT.—

(1) IN GENERAL.—Funds appropriated pursuant to the authorization under this section for the acquisition by Federal agencies of products under subsection (a) shall be available for such acquisitions only in an

amount which does not exceed 10 percent of that portion of the cost of the product acquired under such subsection that exceeds the cost of comparable conventional products. No manufacturer, or any affiliate thereof, shall receive, in any one fiscal year, an aggregate amount in excess of 20 percent of the funds appropriated for such fiscal year pursuant to this section.

(2) COST TO AGENCY.—The Administrator shall ensure that the cost to any Federal agency receiving products under this section shall not exceed the cost to such agency of a comparable conventional product.

(e) INELIGIBILITY.—Federal agencies are ineligible to receive funds under this section for reimbursement of costs to buy products that such agency is required by law to purchase.

(f) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated for fiscal year 1991 and each of the next following 4 fiscal years the sum of $5,000,000 to carry out the purposes of this section.

SEC. 5. INTERAGENCY COUNCIL.

(a) ESTABLISHMENT.—The Administrator shall establish an Interagency Council to encourage the use and development of agricultural commodity-based plastics, coordinate activities under this Act, and to develop uniform definitions,

standards, and testing methods for degradable plastics products.

(b) MEMBERS.—The Council established under subsection (a) shall include the—

(1) Administrator of the General Services Administration;

(2) Secretary of Agriculture;

(3) Secretary of Energy;

(4) Secretary of Defense;

(5) Secretary of the Interior;

(6) Administrator of the Environmental Protection Agency;

(7) Commissioner of the Food and Drug Administration;

(8) Director of the National Institute of Science and Technology;

(9) Director of National Science Foundation;

(10) Director of the Office of Technology Assessment; and

(11) heads of all other Federal departments and agencies as the Council considers appropriate.

(c) ORGANIZATION AND PROCEDURE.—The Council shall be chaired by the Administrator of the General Services Administration. The Administrator of the Environmental Protection Agency, the Director of the National Institute of

Standards and Technology, and the Commissioner of Food and Drugs shall act as Vice-Chairpersons of the Council. A Vice-Chair may act as Chair in the absence of the Chair. Any dissenting views of a Vice-Chair from a decision of the Chair in the discretion of the dissenting Vice-Chair, may be described in the report to the Congress required under this section. The Chair shall consult with the Vice-Chairs as to the dates and agendas of meetings.

(d) CONSULTATION AND COOPERATION WITH PUBLIC AND PRIVATE ORGANIZATIONS.—In carrying out its duties, the Council shall seek the participation, through consultation and cooperation, of other public and private organizations, such as the American Society for Testing and Materials and the Society of Plastics Industry, which have a significant interest in the research and development of degradable plastics technology. Reports containing details of meetings, lists of activities and other communications shall be submitted as described in subsection (k).

(e) DUTIES.—The Council shall, prior to the expiration of the 24-month period following the date of the enactment of this Act, establish uniform definitions, standards, and testing methods for degradable plastic products.

(f) DEFINITIONS FOR DEGRADABLE PLASTIC PRODUCTS.—The Council shall establish definitions for degradable plastic products including but not limited to, biodegradability,

photodegradability, chem-biodegradability, environmental degradability, biodeterioration, and enhanced degradability.

(g) STANDARDS FOR DEGRADABLE PLASTIC PRODUCTS.—The Council shall establish standards for degradable plastic products. In developing these standards, the Council shall consider—

(1) the initiation and rate of degradation of such products under different environmental and biological conditions, and

(2) the risk, if any, degradable plastics pose to human health and environment, including the effects on ground, water, soil, and air.

(h) TESTING METHODS FOR DEGRADABLE PLASTIC PRODUCTS.—In order to evaluate the performance and suitability of plastic products for degradability, the Council shall establish such uniform methods of testing as may be necessary.

(i) MEETINGS.—The Interagency Council shall meet within 30 days of the date of the enactment of this Act, and shall meet a minimum of 6 times per year.

(j) PERSONNEL.—The detailing of personnel from any Federal agency to the Interagency Council shall be permitted.

(k) REPORT.—Not later than 9 months after the date of the enactment of this Act, the Council shall prepare and

submit to the Committee on Governmental Affairs of the Senate and the Government Operations Committee of the House, a report that contains the status of duties under this section. Such report shall include, but not be limited to, a summary of all activities, projects, and programs undertaken by the Council; progress achieved in fulfilling such duties; meetings, activities, and contacts with other Federal agencies and public and private organizations; a list of projects and program objectives to be carried out in the 12-month period following the month in which such report is submitted; and an accounting of agency resources expended in this effort.

SEC. 6. FOOD AND DRUG ADMINISTRATION.

(a) FOOD ADDITIVE ASSESSMENT.—The Commissioner of Food and Drugs, in cooperation and consultation with the Administrator of the Environmental Protection Agency and the Director of the National Institute for Science and Technology, shall perform an assessment of the safety of indirect food additives intended to increase the degradability of plastic food-packaging materials. In performing this assessment, the Commissioner of Food and Drugs shall consider, among other things—

(1) the effect of degradability on the shelf-life of the package; and

(2) the potential migration of the additive from the package to the food.

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(b) REPORT TO CONGRESS.—Not later than 12 months after the date of the enactment of this Act into law, and annually thereafter until completion of the food additive assessment, the Commissioner of Food and Drugs shall submit to Congress a report detailing the activities undertaken to conduct the food additive assessment, a project timetable listing overall objectives with planned activities and programs for completion of the food additive assessment, and an accounting of staff resources spent to conduct this assessment.

TESTIMONY OF JOAN G. HARN
OCEANS AND ENVIRONMENT PROGRAM
OFFICE OF TECHNOLOGY ASSESSMENT
U.S. CONGRESS

BEFORE
SENATE COMMITTEE ON GOVERNMENTAL AFFAIRS

ON
DEGRADABLE PLASTICS AND MUNICIPAL SOLID WASTE MANAGEMENT

JULY 18, 1989

Mr. Chairman:

It is a pleasure to be here this morning. My name is Joan Harn. I am an analyst at the Office of Technology Assessment and have worked on the degradable plastics section of OTA's study on municipal solid waste (MSW), entitled *Facing America's Trash: What Next for Municipal Solid Waste?* The study was initiated at the request of the Senate Committee on Environment and Public Works, and the House Committees on Energy and Commerce and on Science, Space and Technology. The full Report, which was approved by the congressional Technology Assessment Board in June, will be published late this summer. The requesting committees released an interim version of the Report's summary on June 18, 1989.

OTA concludes that the main concerns about MSW stem from a decline in landfill capacity, health and environmental problems associated with poorly operating facilities in the past, rising management costs, and a growing consensus that more recycling and less generation of MSW are desirable. With respect to Federal initiatives, OTA concluded that the government can help by addressing immediate issues such as completing regulations for MSW management methods (i.e., landfills, incinerators, and recycling and composting

operations), interstate transportation, and information flow. OTA also suggested that a comprehensive Federal policy for MSW -- one that addresses the use of materials, from product design and manufacturing through distribution, consumption, and disposal -- is essential to provide a broader context in which specific MSW programs can be developed and implemented.

This broader context, focusing on how society uses materials, is directly related to the issue being discussed today. Designing plastic products to be degradable is a concept that has received considerable attention recently. Proponents contend that degradable plastic products have potential environmental benefits, in terms of reducing litter and alleviating some capacity problems at MSW landfills. In addition, because some degradable products are composed partly of agricultural commodities such as cornstarch, increased use of such products would provide economic benefits to producers of the commodities.

I will focus my testimony on how degradable plastics relate to the major MSW concerns of declining landfill capacity and increasing recycling, as well as the need for uniform standards, definitions, and testing methods.

DEGRADABLE PLASTICS, LANDFILL CAPACITY, AND RECYCLING

Materials can be degraded by the action of microorganisms, light, and chemicals -- biodegradation, photodegradation, and chemical degradation, respectively. All of these mechanisms have been used for various degradable plastics. For example, some biodegradable plastics are designed with starch, and the product breaks apart when microorganisms digest the starch. Photodegradable plastics are designed with chemicals, for example, that react

when exposed to ultraviolet light, with the product breaking apart. For some photodegradable products, once they are exposed to light and the reaction is initiated, they will continue to degrade in the absence of light.

Photodegradable products have been more available commercially and include degradable agricultural mulches and the degradable six-pack beverage rings used to alleviate litter problems and strangulation of wildlife. Biodegradable products are a more recent development; they may be especially applicable in situations where moisture and microorganisms are present, including agricultural mulching and composting.

Degradable Plastics and Landfill Capacity

Two major methods have been suggested for alleviating landfill capacity problems. One is to increase degradation of materials within landfills and the other is to keep materials out of landfills in the first place. The former suggestion needs to be examined carefully for two reasons. First, degradation of materials at landfills is a source of the environmental health and safety problems associated with poorly performing facilities. Unless it can be shown that degradable plastics will degrade into environmentally safe byproducts, nondegradable plastic products may create fewer environmental risks at landfills. Second, there is now evidence that degradation rates in landfills are very slow for all materials because they are designed to be isolated from light, water, and air. Thus, degradable plastics may provide few actual benefits in terms of saving landfill capacity.

Diverting materials away from landfills, through activities such as composting yard wastes, has the potential for alleviating landfill capacity problems in some areas. The diversion of yard wastes, which make up roughly

20 percent of the MSW entering landfills nationwide, also has the potential to improve environmental safety by reducing leachate at landfills and by improving combustion efficiency and reducing nitrogen oxide emissions at incinerators. If a decision is made to divert yard wastes, degradable plastics bags are preferable to nondegradable plastics for collection, provided degradation products are environmentally safe. Some communities are testing this approach now.

Degradable Plastics and Recycling

OTA identified three factors that limit the expansion of post-consumer plastics recycling: 1) the low rate of collection, although many communities are adding plastics to their recycling programs; 2) the lack of technologies to separate different plastic types; and 3) the lack of performance standards and testing procedures to assure fabricators that recycled resins are of sufficient quality to meet their needs (the American Society of Testing and Materials (ASTM) is addressing this). The problems associated with separation and quality are keys to the controversy about degradable plastics and recycling.

The plastics industry (i.e., those who produce nondegradable plastics) contends that if degradable plastics get mixed into the post-consumer plastic waste stream destined for recycling, they might threaten the physical integrity of products made from recycled plastics. In turn, this could cause complicated liability problems for product manufacturers and potentially reverse current increases in the recycling of plastics.

Technical experts who work with degradable plastics disagree. They contend that potential adverse effects will vary depending on the particular degradable plastic, but that the problems will be minimized by: 1) dilution of the degradable material; 2) addition of appropriate steps to the recycling process (such as chemical treatment) to negate any effects of degradable materials; or 3) careful consideration of the intended uses and properties of the recycled products. They consider quality control of the incoming resin, processing, and the final product as the key to avoiding adverse impacts of degradable plastics on recycling.

Addressing this uncertainty is fundamental to dealing with concerns of the plastics industry about the expanded use of degradable plastics, but the issue cannot be resolved until further research is conducted. Quality control for recycled plastics is only now being addressed by the American Society for Testing and Materials (ASTM), just as it is looking at the issue of definitions, performance standards, and testing methods for degradable plastics.

DEFINITIONS, PERFORMANCE STANDARDS, AND TESTING METHODS

Proposed legislation such as S. 1237, the "Degradable Commodity Plastics Procurement Act," is critical for resolving uncertainties about degradable plastics. S. 1237, for example, would establish definitions, standards, and testing methods, all of which are essential for the long-term success of expanded markets for degradable plastics.

Definitions, standards, and testing methods need to consider composition and performance of products, what happens when the products degrade, and how they affect management methods for MSW. Long-term acceptance of degradable

plastics will be related to how these products perform, not just as useful products but also when they are discarded. The public is generally skeptical of new methods for dealing with MSW, due to the health and environmental safety problems that have occurred at many older facilities. Despite this, there is currently a great deal of public enthusiasm for biodegradable plastics. To sustain this support and satisfy the concerns of both environmentalists and the large nondegradable plastics industry, unanswered questions must be addressed.

Most important is the question of what is really meant by degradable plastics. Currently, there are no agreed upon standards or definitions. Questions about the rate and timing of degradation in different environments and about the environmental safety of the byproducts of degradation either have not been addressed or the research to answer them is only now underway.[1] From an environmental perspective, the concern is over the size of initial fragments that result from degradation and what will happen next -- whether the material will ultimately degrade into inert dust-sized particles, into intermediate organic chemicals, or eventually into carbon dioxide and water. The fate of additives incorporated into degradable plastic products also matters. Additives include a variety of mineral and chemical derivatives that are extremely important in creating plastic materials with specific properties; for example, lead and cadmium are used to color many resins.

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[1] This is true even for using degradable plastics to alleviate problems with persistent marine debris. Scientists are now concerned that degradable plastics in marine waters may serve only to substitute one hazard for another. That is, with the use of degradable plastics, the hazard of ingesting plastic fragments may replace the hazard of entanglement in nondegradable plastics.

Unfortunately, there is little information on the fate of these substances when plastic products, whether degradable or nondegradable, become part of the MSW stream.

Much of the public interest in making plastics biodegradable is derived from the push in the 1970s to alleviate water pollution problems by using biodegradable detergents. But the use of the term biodegradable differs in these cases. Biodegradable plastics, for example, often are composed of plastic resins plus an organic matrix such as corn starch. For these plastics, product manufacturers generally are talking about plastics that will disintegrate into dust (i.e., a mixture of resins and residues from the degradation of the organic matrix) because of the action of organisms. In the case of detergents, the products are transformed by organisms into chemical building blocks of life (e.g., nutrients, carbon dioxide, and water). Some biodegradable plastics are claimed to degrade into carbon dioxide and water, but only over a long period of time (years or decades). When the public understands this distinction, there may be a backlash against biodegradable plastics that only disintegrate, unless there is assurance that the degradation products are benign.

Definitions, Standards, and Government Procurement

The ASTM is currently working to develop definitions, performance standards, and uniform testing methods for degradable plastics. This effort will help solve some of the problems discussed above. However, more work will be necessary to establish a viable government procurement program, as called for by S. 1237, for degradable plastics made from agricultural commodities.

Government procurement programs for such products will confront many of the same difficulties as procurement programs for recycled products. In particular, guidelines will be needed to define and verify the amount of agricultural commodities used in such plastics. ASTM's work will help ensure that consumers understand the general nature and performance of the products. However, it is not likely to be sufficient for verifying product content or providing precise information on how a product will degrade under different conditions.

ASTM's definitions of degradable plastics are being developed through a consensus process. The effort has been directed at the loss of performance and physical integrity of degradable plastics and the mechanisms by which it occurs. This type of definition is based on the least common denominator of performance -- i.e., that the materials will disintegrate into small fragments. Such definitions are designed to be inclusive of all types of degradable plastics.

However, they will not fulfill some needs of a procurement program designed to increase purchases of degradable plastic products. Officials implementing such a program must be able to distinguish among similar products of varying composition, but verifying the amount of different ingredients in commercially available degradable plastics may be especially difficult. For some products, for example, the fabricator adds a small percentage of the degradable ingredient (e.g., corn starch, vinyl ketone) to the plastic resin, along with other additives such as color. Methods will be needed to verify that the appropriate amount of ingredient has been added. For other products,

the resin itself is degradable (e.g., bioengineered resins, ethylene carbon monoxide) and does not require the fabricator to add a specific amount of a degradable ingredient into the product.

S. 1237 provides a mechanism for meeting these needs by establishing an Interagency Council to encourage the use of agricultural commodity-based plastics. The Council would develop uniform definitions, standards, and testing methods for degradable plastic products. These could be specifically oriented toward the needs of procurement programs.

The same factors I've mentioned before need to be considered when definitions, standards, and testing methods are developed by the Council under S.1237: 1) the composition of products qualifying for the procurement program; 2) the effect of degradable plastics on recycling efforts; and 3) the environmental fate of resins and all additives when any product is disposed of in landfills, incinerated, or thrown away as litter.

To ensure environmental safety, consideration needs to be given not just to the degradable plastic itself, but also to any additives such as color that might be included when plastic products are made. Such additives currently are regulated only in some cases, for example by the Food and Drug Administration when it reviews food packaging. However, many consumer products are not subject to such scrutiny. Standards should consider what happens to additives when degradable plastic products are used in other applications.

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CONCLUDING REMARKS

In summary, the expanded use of "degradable" plastics for solving MSW problems is questionable until the uncertainties about what happens to them when they are landfilled, incinerated, or mixed with nondegradable materials for recycling are answered.

At the same time, however, the use of agricultural commodities in general deserves closer attention in product design and MSW management. One role which appears promising is the use of degradable plastic bags for collecting yard wastes. In addition, making plastics degradable is not the only way that agricultural commodities can help MSW management. For example, newly developed starch adhesives may improve the quality of polyethylene terephthalate (PET) recycled from soda bottles. Current adhesive residues can discolor or chemically degrade recycled PET, but new starch adhesives for labels and "basecups" may be able to avoid this problem. Another new starch adhesive for basecups is being developed to allow PET bottles to be shipped in less protective material than is currently required, thereby reducing commercial packaging waste.

S. 1237 would establish much of the framework needed to evaluate the true potential of degradable plastic products and to promote fulfillment of that potential. To close, I would like to commend you for your efforts to develop nonfood uses for agricultural products to solve some difficult environmental problems.

RESPONSES TO SENATOR GLENN'S QUESTIONS ABOUT DEGRADABLE PLASTICS

1. What role should the federal government play in establishing standards, definitions, and testing methods for degradable plastic materials, and why?

The Federal role in establishing standards, definitions, and testing methods for degradable plastic materials depends very much on how the Federal government would use the standards, etc. Two possibilities include: 1) a procurement program (such as the one specified by S. 1237), in which those materials that meet the standards and definitions are given a preference in purchasing decisions; or 2) a regulatory program to ensure that commercially available degradable materials do not pose health or environmental risks and do not cause problems for plastics recycling.

For procurement, ongoing activities by ASTM will likely meet some, but not necessarily all, of the needs of a Federal program for degradable plastic materials. ASTM is already in the process of developing standards, definitions, and testing methods that are likely to result in de facto industry standards. However, the ASTM effort is not likely to be sufficient for verifying product content, or providing precise information on how a product will degrade under different conditions or its impact on the recycling process.

A regulatory program would entail much greater Federal involvement in the degradable plastics industry. If the program's intent is to extend the standards, definitions, and testing procedures developed by organizations such as ASTM beyond Federal procurement, then several questions need resolution. For example, would individual degradable plastic products be subject to a risk assessment or cost-benefit analysis prior to receiving approval for marketing, or would products simply have to pass certain laboratory performance tests?

Who would certify that products meet the regulations -- manufacturers (as is now done with many products that meet FDA requirements) or the government? How would the regulations be enforced? What types of civil and criminal penalties would be allowed?

2. Do you feel it is important, since so many federal agencies share jurisdiction for the regulation of degradable plastic products, that a lead agency be designated to better coordinate government policy in this area?

Coordinating government policy on degradable plastic products would be very useful. For example, it could help insure that the issues and concerns of various Federal agencies are considered when a Federal policy is developed and that individual decisions of the agencies are consistent with that policy.

Designating a lead agency to coordinate policy may be appropriate, but it is not necessary, and it may be difficult to do. Any of several agencies could have important roles, for example, depending on the particular issue being considered:

- o environmental protection -- EPA;
- o consumer safety -- Food and Drug Administration, Consumer Products Safety Commission
- o establishment of product standards -- NIST; and
- o procurement programs -- Department of Commerce, GSA, and/or EPA (EPA is already charged under the Resource Conservation and Recovery Act with developing procurement guidelines for recycled products).

The most important need is to ensure that these agencies coordinate their activities so that a consistent policy emerges. Mechanisms other than a lead agency--for example, an interagency council or task force, Congressional oversight--may be more effective in ensuring that cooperation occurs.

3. In your view, is more research needed on degradable plastics to determine their feasibility and utility <u>before</u> uniform standards can be developed? Or, do you think a sufficient foundation of knowledge exists today that provides a basis for setting such standards in the near future?

The need for research depends very much on the nature of Federal policy on this issue. If the intent of Federal policy is to increase use of degradable plastics, then more research is needed to ensure that this use does not create more environmental problems than the use of nondegradable plastics. In this case, specific areas needing more research include the effects of degradables on plastics recycling and the environmental fate of resins and all additives when a degradable plastic product is disposed of in landfills, incinerated, or thrown away as litter. Close monitoring of the EPA studies described at the July hearing on S. 1237 should indicate how quickly research results could yield information to develop standards.

4. Some have asserted that degradable products will have a minimal effect on landfill capacity because a recent study claimed that newspapers, hot dogs, and conventional plastic bags--some which were disposed of in landfills 20 years ago--had remained intact. What stock do you place in this assertion, and what implications does it have for degradable plastics?

Data on degradation in landfills is limited. Nevertheless, available data from recent excavations by William Rathje and landfill simulation studies conducted by EPA in the 1970s indicate that not much degradation occurs in landfills.

If these results prove to be the general rule, then we must examine the methods that are generally suggested for alleviating landfill capacity problems--increasing degradation of materials within landfills and keeping some materials out of landfills in the first place.

Promoting degradation has its own set of problems, not only how to make it happen in the first place, but how to do it in an environmentally safe manner. Improper control of leachate and emissions at landfills is one source of the environmental health and safety problems associated with poorly performing facilities and is in large part responsible for public distrust of waste disposal facilities. Since most existing landfills do not have proper pollution controls (e.g., liners, leachate and methane collection, groundwater monitoring), and because it is not clear whether degradable plastics will degrade into environmentally safe byproducts, nondegradable plastic products may pose fewer environmental risks at landfills today.

Assuming the above concerns can be satisfactorily resolved, the capacity saving benefits of having some plastics degrade in landfill would be real, but not dramatic. As an example, plastics comprise roughly 7 percent by weight of the material entering landfills (according to models prepared by Franklin Associates). Half of this amount is containers and packaging, and the remainder is durable goods. Data on the volume of plastics in landfills is not very good; however, EPA estimates that plastics take up 2-3 times the space for a given weight than other landfill materials. Thus, assuming that containers and packaging are made from degradable plastics, and durable goods are not, about 7-10 percent of landfill capacity could be conserved by using degradable plastics. This assumes that degradation really takes place under landfill conditions and that the residue does not require any space.

More landfill capacity can be conserved by keeping out waste materials that can be managed safely in ways such as recycling (including composting). For example, separating yard wastes for backyard or municipal composting would serve two purposes. First, it would divert a large portion (20 percent or

more--by weight, volume information is not available--depending on the area and season) of the MSW stream from landfills. Second, it would remove a major source of the degradable material that contributes to leachate formation.

Landfill capacity also can be conserved if we generate less municipal solid waste in the first place. OTA's report, *Facing America's Trash: What Next for Municipal Solid Waste*, suggests that national MSW policy should include the strategy of waste prevention. Prevention refers to activities by manufacturers (e.g., modifying products, including packaging) and consumers (e.g., modifying purchasing decisions) that reduce the toxicity or quantity of products before they are purchased. Reducing toxicity would make all management methods safer and could restore public confidence in waste management policies and programs. Quantity reduction would mean that the useful life of existing and future waste management facilities would be extended and new replacement capacity could be developed at a slower rate. OTA cannot predict the extent to which waste prevention will occur, but this approach offers important potential benefits that are worth pursuing.

STATEMENT OF

JAMES L. DePROSPERO, JR.

ASSISTANT COMMISSIONER FOR COMMODITY MANAGEMENT

FEDERAL SUPPLY SERVICE

GENERAL SERVICES ADMINISTRATION

BEFORE THE

SENATE COMMITTEE ON GOVERNMENTAL AFFAIRS

July 18, 1989

Mr. Chairman, I am James L. DeProspero, Assistant Commissioner for Commodity Management, Federal Supply Service, General Services Administration. Mr. Richard G. Austin has asked that I represent him before you today to provide GSA's views on S.1237 a Bill requiring that the Administrator of General Services:

- Identify products in the GSA purchasing catalog that can be made from degradable plastics technology, and that are environmentally safe, with particular emphasis on agricultural commodity-based products; and

- Make these products available to the Federal Government through the competitive bidding process; and

- To chair an interagency council to develop and coordinate the implementation of the Act.

I am accompanied today by Harold Murrell, the Director of our Office and Paper Products Commodity Center.

We agree that uniform definitions, standards for performance, and testing for performance, safety and health be developed and agreed upon prior to attempting to undertake a major procurement program for degradable plastic products.

We continue to believe as stated in our previous testimony in the hundredth Congress that a procurement program which promotes the use of degradable plastic can be implemented within existing statutory authority, and, we therefore oppose S.1237. We have some additional concerns that we consider very important to the ability of GSA to implement such a Bill, and to the ultimate success of a procurement program to promote the manufacture and purchase of degradable plastic products, and to promote the continued development of degradable plastics technology.

Of major concern is the use of a single award competitive procurement procedure, as described in this Bill using a very complicated sliding scale evaluation process based on difficult to quantify factors. The single award competitive procurement process works extremely well for established commercial product lines, but could be a real deterrent to the commercialization of existing degradable plastic products and to the development of new degradable plastic products. Single award competitive procurement often results in a winner take all situation with the Government business door then closed to other potential suppliers trying to establish both commercial and Government markets. Another competitive procurement process, a Multiple Award Schedule (MAS) could be used that has some significant pluses for this situation. A MAS would eliminate the need for the complicated sliding scale evaluation, would allow all interested and acceptable suppliers of degradable plastic products to

simultaneously seek Federal Government business and obtain the benefits of this business to the establishment of competitive products, and would eliminate the probably lengthy process of identifying products in the GSA system that could be supplied degradable as the procurement could be left open to all degradable plastic products appropriate for Government use, and would allow for immediate implementation of the procurement process since the need to develop many item specifications would be eliminated, and would involve a fewer number of procurement resources. The establishment of uniform definitions, standards and test procedures would still be necessary so that users could be confident that chosen products would do the job, degrade as required and produce only safe by-products upon degradation.

To be the source for products for Government users GSA must be competitive. To undertake a social minded program such as proposed by S.1237 could well put our industrial funding program in jeopardy of revenue losses due to users switching from GSA to commercial sources.

We have been doing some work in the area of attempting to procure degradable plastic bags during the past year. I would like to briefly relate these recent GSA contracting efforts as a possible indication of the state of the industry for this type of product, certainly a leader in the use of degradable technology.

For about a year, we have been vigorously pursuing a program to encourage manufacturers and suppliers of degradable plastic bags to apply to offer their products to Federal activities through the GSA Federal Supply Service's New Item Introductory Schedule (NIIS). This program allows suppliers of new or improved products an opportunity to negotiate and obtain a contract with GSA to supply their products directly to Federal activities through the NIIS.

Having this contract allows Federal activities to make immediate procurements of their products. The NIIS is a specialized Multiple Award Schedule thereby permitting potentially all acceptable suppliers of degradable plastic bags to have contracts and seek Federal Government business.
We first placed a notice in the Commerce Business Daily (December 7, 1988), seeking applications for the NIIS in general and specifically from firms offering biodegradable plastic products.

Then in January of 1989, we mailed letters to 122 firms manufacturing or supplying plastic bags, as well as to firms involved with degradable plastics, encouraging them to apply to the NIIS to supply degradable plastic bags. To date, we have received only 5 applications; we expect to award the first contract this month and look forward to awarding additional contracts in the near future.

We believe the response to our efforts illustrates the state of the degradable plastic industry i.e., that the available technology has not yet been translated, in any large way, to marketable products. This should change fairly rapidly for plastic trash bags as more and more localities require this product to be degradable.

This again supports the use of a competitive procurement process that allows for all emerging manufacturers and suppliers to have an opportunity to obtain Government business, thus encouraging product development. The MAS fits this situation particularly well.

GSA believes, whether mandated by statute or not, that it would be more appropriate for the first chairman to be from a technical activity rather from GSA because of the research and development expertise required. Further, we want to emphasize that 2 years is too short a period in which to develop a standard.

From a professional procurement standpoint, we are convinced, as stated earlier, that a procurement program promoting the use of degradable plastic products can be implemented under existing statutory authority. Under the existing conditions of emerging technologies and new product development, the most viable procurement method is the Multiple Award Schedule. In view of the above, we cannot support enactment of this Bill.

Mr. Chairman, this concludes my testimony. I will be happy to address any questions you or the committee may have.

General Services Adminsitration
Federal Supply Service
August 18, 1989

Answers to the Eight Questions
submitted by Brian Dettelbach,
Assistant Counsel to Senator Glenn,
concerning the GSA
Testimony on S.1237

Question #1, WHAT WOULD BE THE MOST EFFECTIVE PROCUREMENT MECHANISM?

GSA Response - The New Item Introductory Schedule (NIIS) is a specialized type of a Federal Supply Schedule. Under the program, GSA provides Federal agencies with a simplified process of acquiring commonly used supplies in varying quantities at lower prices while obtaining discounts associated with volume buying. Indefinite delivery, requirements type contracts are awarded to commercial firms to provide supplies at stated prices for given periods of time. This period is usually three years under the NIIS program. The Federal Supply Service issues a publication, quarterly, entitled, "The New Item Introductory Schedule", containing the information needed for placing delivery orders with the contractors. See exhibit A for a copy of a New Item Introductory Schedule.* Under this program, Federal agencies -

(1) Issue orders directly to the contractors;
(2) Receive shipments;
(3) Pay the contractors; and
(4) Administer individual orders

The NIIS is used to introduce new or improved products into the Federal Supply System. Potential suppliers submit applications, on GSA Form 1171, Application for Presenting New Products, (see exhibit B) through any GSA Business Service Center (BSC). The BSC screens the applications and forwards them to GSA for review and acceptance or rejection. This review considers such factors as possible duplication of present supply support items anticipated demand, and health, safety and legal requirements. The federal user must obtain the contractor's catalog and pricelist to use the schedule effectively. A contractor is required to make their documents available upon request. (See exhibit C for a copy of the Biodegradable Plastic Bags catalog/pricelist awarded under the NIIS).

* The exhibits referred to throughout have been retained in the Committee files.

Question #2 - HOW WOULD DEGRADABLE PLASTIC PRODUCTS BE IDENTIFIED AND MADE AVAILABLE TO FEDERAL AGENCIES FOR PURCHASE? HOW DO YOU ESTABLISH A PREFERENCE PROGRAM THAT FAVORS, ALL OTHER FACTORS BEING ROUGHLY EQUIVALENT, THE PURCHASE OF DEGRADABLE PRODUCTS OVER COVENTIONAL ITEMS?

GSA Response - Currently, GSA has two broad methods of communicating supply availability to Federal customers. Under the MAS Program, contractors are required to distribute GSA approved pricelists/catalogs to interested using activities. See exhibit C for a copy of the Biodegradable Plastic Bag pricelist that is currently available under the NIIS. Under the stock program, a GSA Supply Catalog is made available to ordering agencies. See exhibit D for an extract from the Supply Catalog covering nondegradable plastic bags.

Concerning a preference program for degradable plastic products, GSA is unaware of a technique to support such a concept under current conditions. To begin with, the statement "all factors being roughly equivalent", we assume means that nondegradable and degradable plastic products are equivalent in performance, quality, safety, and recyclability characteristics as well as availability and delivery times. As EPA and NIST testified, we are not there yet and may not be for some time, if at all. We are simply at a loss on how to describe an effective preference program with the Senator's goals in mind and we are not sure if such a program would be of benefit to the Government. We will provide, however, two hypothetical situations under two different procurement programs which might be construed as a preference program. We qualify these examples with a strong caveat as we are not sure of their effectiveness to meet the intended goals of the proposed legislation.

GSA has, two major supply programs, the Federal Supply Schedules Program and the stock program. As we previously stated in our testimony covering S.1237, GSA believes that it has statutory authority currently to contract for biodegradable plastics and to support its assertion GSA just let a NIIS schedule contract for this new technology.

The price of biodegradable plastic bag items on the NIIS average more than 40% percent higher than their non-degradable counterparts on the GSA stock program. The only practical preference program in this scenario is to require agency quotas similar to those noted in report 101-81 on the National Defense Authorization Act for the fiscal years 1990 and 1991. The DOD directive requires DOD activities to purchase 10% of their plastic bags in a biodegradable form. However, one could possible argue that a price preference program is not necessary in this scenario as you have two dissimilar commodities. Agencies could probably justify higher costs on the degradable plastics on such consideration as:

(1) Specific or unusual requirements such as differences in performance characteristics;

(2) Special features of one item not provided by comparable items that are required in effective program performance.

In the second scenario, the biodegradable configuration competes head to head with the nonbiodegradable products. This assumes that adequate specifications and/or standards are available to evaluate both products on a common basis. In order to support this emerging technology, Congress may have to legislate appropriate price differentials to promote the biodegradable configuration, assuming again that a common base can be developed. However, this maybe difficult, if not impossible, to do. See response to question #3.

QUESTION #3 - WHAT IS THE SIMPLEST METHOD FOR AWARDING COST DIFFERENTIALS?

GSA Response - It is inappropriate to discuss the neccesity for requiring price support or preferential price differentials to support the proposed legislation. Degradable items and non-degradable items are not identical items of supply. To promote degradable by developing a price preference factor is difficult as in some areas lack of land fill or environmental concerns may be overriding concerns regardless of everything else. In other areas, energy considerations and benefits to domestic agriculture may be overriding concerns. Therefore, awarding cost differentials may not be appropriate to this legislation. GSA's approach is to move gradually and cautiously through a specialized procurement technique (NIIS). Under this procurement program, multiple suppliers of new and improved products are given the opportunity to negotiate and obtain a national scope contract to supply their innovative products directly to federal customers. Under this method of procurement, the Government is essentially relying on commercial and proprietary specifications. The buyer's experience, favorable versus unfavorable, with the products quality, performance and price will determine the ultimate economic success or failure of the product under this unique procurement technique that GSA has successfully utilized for over 20 years. This interim approach gets new technology out to the Federal Government while uniform standards and specifications are being developed.

Therefore, GSA believes that a practical and immediate solution to accommodate the intended goals of S.1237 lies within existing statutory authority as well as a preference program similar to that envisioned by 101-81 and requiring an agency to acquire a specified percentage of their requirements in a biodegradable configuration. In order to implement these ideas, GSA is proposing the following revision to S.1237:

Section 1, Short Title

No change

Section 2, Findings and Purpose

No change

Section 3, Definitions

Delete (3) Government Purchasing Catalog
Delete (6) Sliding Scale Rating Method

Section 4, Encouragement of Development and use of Commodity Based Plastics

Delete in its entirety and substitute:

(a) General Services Administration - the Administrator of the General Services Administration shall -

(1) ensure that products assigned commodity management responsibility to GSA that can be made from degradable plastics technology, and that are environmentally safe, as determined by the Interagency Council, with particular emphasis in agricultural commodity based products, shall be made available to agencies of the Federal Government to the maximum extent possible.

(2) ensure that a market research and analysis be conducted to ascertain the availability of degradable plastics to meet the needs of the Government and to identify the market practices, including warranty terms, of firms engaged in producing, distributing, and supporting these products. GSA shall conduct such research and analysis as needed to ensure full and open competition, consistent with the requirements of the competition in contracting act, PL 98-369, and that the Government's needs are met in a cost effective manner.

(3) ensure that the most effective and economical method of supply and method of procurement decision is made to acquire and distribute these products to federal agencies. Appropriate procurement and supply factors must be considered to determine the best method of procurement and supply to implement the determination, such as -

(A) the cost and demand for the item
(B) the cost of Government operations
(C) commerciality
(D) manufacturing and distribution processes
(E) customer delivery time
(F) availability of specifications and standards
(G) agency minimum needs
(H) state of technology - constantly changing or stable
(I) availability of competition
(J) potential sales volume

(b) Preference Program

(1) Use of Government supply sources - All federal agencies will be required to purchase degradable plastics from the General Services Administration as a mandatory source of supply. As such products become available through the GSA supply programs (stock, special order program or Federal Supply Schedule), agencies will ensure that a good faith effort is made for the purchase of products in a biodegradable configuration with each agency establishing a reasonable goal for fiscal years 1990 and 1991.

Absent the identification of problems as reported to the Government Affairs Committee, agencies are directed to increase the acquisition of degradable plastic products where available each succeeding fiscal year commensurate with agency goals.

(c) Industrial Funding - If the most effective and economical method of supply for degradable plastic products is determined to be other than the GSA stock program, which is currently industrially funded, then GSA will receive a supplemental appropriation for any revenue shortfall.

Section 5 - Interagency Council

Recommend revision to identify the Administrator, National Institute of Science and Technology (NIST) as the individual responsible for establishing the Interagency Council to develop uniform standards and test methods, etc., and that NIST also chair this council. The Administrator GSA shall act as a Vice Chairperson.

The time frame of two years, or such time as determined by the Interagency Council, will be used to establish uniform standards necessary to ensure a successful program.

We further recommend, that the funds initially discussed in section 4(d)(1) be used instead to fund the Interagency Council's efforts to develop the uniform standards and testing methods that will be crucial to the long term success or failure of this emerging technology, as well as funding the market research and contracting effort.

QUESTION #4 - WHAT PROCUREMENT SYSTEM SHOULD BE USED UNTIL STANDARD ARE DEVELOPED?

GSA Response - See GSA response to question 1 above. Although GSA is recommending the Multiple Award Schedule Program as an effective procurement mechanism in the interim period while standards are being developed, the final method of supply decision (stock versus MAS) or final method of procurement (sealed bid versus MAS) will depend on a variety of conditions.

Four general criteria must be met to acquire items under the schedule program: (1) Impractical to describe with a Commercial Item Description, Purchase Description, or Federal Specification; (2) specific technical requirements are unknown; (3) agency needs can be satisfied among several functionally similar products with significant variances in prices and features; and (4) Technology is changing rapidly. Although standards can possibly be written on degradable plastic bags (NIST estimates 3-5 years) the technology may be in such a flux that to award on standards which may become obsolete overnight may not be in the best interest of the Government.

QUESTION #5 - PLEASE PROVIDE THE COMMITTEE WITH A SUMMARY OF THE DEGRADABLE PLASTIC BID SOLICITATION MENTIONED IN YOUR TESTIMONY, INCLUDING THE TERMS AND CONDITIONS OF YOUR SOLICITATION, A LISTING OF VENDORS RECEIVING THE SOLICITATION, AND THEIR RESPONSES.

GSA Response - GSA has not been passive on this environmental issue; the Federal Supply Service has played a very active role.

GSA first placed a notice in the Commerce Business Daily on December 7, 1988, seeking applications for the NIIS in general and specifically from firms offering biodegradable plastic products (see exhibit E).

In January 1989, GSA's Office Supplies and Paper Products Commodity Center, Region 2 - New York, mailed letters to 122 firms manufacturing or supplying plastic bags, as well as to firms involved with degradable plastics, encouraging them to apply to the NIIS (see exhibit F for a copy of the letter and the mailing list used). The New York office, in order to encourage submission of applications for this new technology decided to waive the prior Federal Government sales requirements.

GSA's first contract under the NIIS was made by the New York office on July 20, 1989, to Hallmark Packaging Products, Inc., of Tampa, Florida. A copy of a blank solicitation generally used to make a NIIS award is shown in exhibit G. This is a type of solicitation used in all NIIS contracts.

QUESTION #6 - IT IS GENERALLY AGREED THAT DEGRADABLE PLASTIC BAGS COST A FEW CENTS MORE THAN NON-DEGRADABLE CONVENTIONAL PLASTIC BAGS. WHAT COST OR OTHER INCENTIVES DID YOU OFFER TO MANUFACTURERS OF DEGRADABLE PLASTIC BAGS TO MAKE THEM COMPETITIVE WITH GENERAL CONTRACTS INVOLVED FOR CONVENTIONAL PLASTIC BAGS?

GSA Response - The NIIS is and Optional use Federal Supply Schedule. As such, the program is a preferred method of supply over commercial sources (see exhibit H). Additionally, the program provides agencies the ability to acquire new technology utilizing simplified ordering procedures. Therefore, unless a firm has such a GSA contract, a competing firm not on a GSA schedule will be at a competitive disadvantage. Estimated sales for all items under the NIIS in fiscal year 1988, amounted to a little over $18 million.

QUESTION #7 - PLEASE LIST THE NAMES OF MANUFACTURERS CURRENTLY PROVI' ING PLASTIC BAGS UNDER GSA CONTRACT AND THE PRICE PAID PER BAG?

GSA Response - See exhibit I for description of plastic products purchased by GSA and see exhibit J for a list of the contractors and the contract prices.

QUESTION #8 - SOME HAVE SUGGESTED GIVING A PREFERENCE TO AMERICAN MANUFACTURERS AND FARMERS IN THE PROVISION OF DEGRADABLE PLASTIC ITEMS TO THE GOVERNMENT. IF THIS WERE TO BE DONE, HOW COULD IT BE ACCOMPLISHED MEETING GSA NEEDS AND REQUIREMENTS?

GSA Response - As discussed with the Senator's staff, this subject has been withdrawn from consideration. It is felt that restrictions on full and open competition would only harm the growth of this new technology. As a matter of reference, Canadian firms are authorized to bid on GSA contracts without restrictions as well as American firms offering products produced in Canada (see exhibit K).

STATEMENT OF
BRUCE WEDDLE
ACTING DIRECTOR OF THE MUNICIPAL SOLID WASTE PROGRAM
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
COMMITTEE ON GOVERNMENT AFFAIRS
U.S. SENATE

JULY 18, 1989

Good morning, Mr. Chairman and members of the Committee. I am Bruce Weddle, Acting Director of the U.S. Environmental Protection Agency's Municipal Solid Waste Program. I welcome the opportunity to appear before you this morning to discuss plastics as a component of the municipal solid waste stream and to provide comments on S. 1237, the Degradable Commodity Plastics Procurement and Standards Act of 1989.

This morning I will begin by describing the contribution of plastic wastes to the municipal solid waste dilemma facing the country today. I will then discuss EPA's activities related to plastics, particularly with regard to the increased use of degradable plastics. I will conclude with comments on S. 1237.

The Municipal Solid Waste Dilemma

The amount of waste we produce, as individuals, and as a nation, has reached staggering proportions. Individually we have moved from discarding an average of 2.5 pounds of solid waste per day in 1960 to an average of 3.5 pounds per day in 1986. These figures translate into a national increase in municipal solid waste generation from 87 million tons in 1960 to 160 million tons in 1986. Solid waste generation is increasing faster than population growth. Further, we expect the increase to continue, with

municipal waste generation reaching 193 million tons per year by 2000.

Current solid waste management practices result in landfilling approximately 80% of municipal wastes, recycling 10%, and incinerating the remaining 10% (either with or without energy recovery). The increasing volume of waste, coupled with dwindling landfill capacity and public resistance to the siting of new landfills and incinerators has led some parts of the nation to a near crisis situation. One-third of the nation's municipal landfills will reach capacity by 1992. As a nation we are being forced to action -- forced to begin to accept our individual and collective responsibility for waste generation and management, and to address the solid waste problem.

In February of this year, EPA published its Agenda for Action, laying out a strategy for dealing with the solid waste dilemma we face. The Agenda stresses the need for integrated waste management, and encourages states and localities to adopt holistic solid waste management plans. Integrated waste management plans combine waste management alternatives such as source reduction, recycling, and reuse with the more traditional disposal options -- such as landfilling and incineration. The exact mix of elements and the relative emphasis on each is determined by local communities following a careful evaluation of the various technical, economic, and social factors which are unique to the particular situation being addressed. However, the Agenda does

establish a hierarchy of preferred practices -- first, source reduction, or reducing the volume and/or toxicity of wastes we produce; second, recycling, which saves resources and extends the useful life of landfills; and, finally, disposal options (primarily landfilling and incineration). We believe that it is time to seriously turn our attention to the front end of the problem by reducing waste generation and by recycling. In addition to publishing the Agenda, EPA has also established a Pollution Prevention Office to ensure high level Agency-wide attention to these priorities.

The Agenda also lays out EPA's views on the roles of the various actors involved in municipal waste management, as well as committing EPA to a series of action items which we are now implementing. The Agenda established a goal to reduce and recycle 25% of our nation's waste by 1992. The challenges facing all levels of government are significant, both for reaching the short term national goal and for achieving a long term solution to the dilemma we now face. Ultimately, we believe that working in partnership with the States, local governments, the waste management industry, and private citizens, we will successfully craft the appropriate solution. Let me turn briefly now to the contribution of plastics to this dilemma.

Plastics in the Municipal Solid Waste Stream

Plastics accounted for 10 million tons, or 7% (by weight), of the 158 million tons of municipal solid waste generated in 1986.

By volume, however, plastics account for a larger percentage. Because we are currently conducting a study to determine the relative volumes of all components of the municipal solid waste stream exact figures are not yet available. Present estimates of the percentage of volume contributed by plastics vary from 14% - 28%. By the year 2000 we expect to see a 60% increase (by weight) in plastics in the solid waste stream. This would mean that 9% of the total municipal waste stream (or 16 million tons) would be contributed by plastics. One primary type of plastic waste dominates -- plastic packaging accounts for half of all plastics in the waste stream.

Current management of plastic wastes closely resembles that of other municipal solid waste. However, in contrast to the 10% recycling rate achieved for municipal wastes overall, only 1% of plastics are being recycled. Most of the recycling of plastics being done at this time is for soft drink containers made of polyethylene terephthalate (PET). Currently about 20% of PET soft drink bottles are recycled. This is one of the many interesting facts we have learned while developing a Report to Congress on Plastics.

Report to Congress on Plastic Wastes

Section 2202 of the 1987 Marine Plastic Pollution Research and Control Act directed EPA to develop a Report to Congress on methods to manage and control plastic wastes. This report is now in final Agency review, and we expect that it will be delivered to the

Congress in September. The Report addresses a number of significant topics of interest to those assembled here today:

--Amounts and types of plastics produced in the U.S.;

--Markets for plastics;

--Impacts of plastics on the marine environment;

--Impacts of plastics on the solid waste stream; and

--Methods to reduce impacts of plastics on the solid waste stream (i.e., source reduction, recycling, and degradable plastics)

Some of the facts and figures I have just given you regarding plastics as a component of the solid waste stream are preliminary findings in this Report to Congress. In addition, I would like to briefly discuss some other preliminary findings which may be of interest to this Committee.

- Production The three largest end products (by weight) associated with plastics production are packaging, building and construction materials, and consumer products. Overall plastics production has grown from 3 billion pounds in 1958 to 57 billion pounds in 1988. Industry predicts future growth (up to the year 2000) to vary from 2.4% to 4%. However, this projection was based on 1985 data, and growth has already been faster than projected.

The term "plastics" encompasses a wide variety of "resins" (e.g., polystyrene, polyethylene), which offer unique properties and functions. In addition, the properties of each resin can be modified by additives. Different combinations of resins and

additives have allowed the creation of a wide array of products meeting a wide variety of specifications. This has important implications for management of plastics in the waste stream, since the potential environmental impacts of degradation by-products may vary significantly, depending on resin type and additives used. In addition, the many different types of plastics affect recycling operations and decisions (i.e., resins can either be recycled together as a mixture or separated into homogeneous resins). In short, while we often speak of plastics as a single entity, there are important variations in these materials which are significant to decisions to be made on waste management options.

Degradable Plastics The manufacture and widespread use of photo- and bio- degradable plastics has been suggested as a method to alleviate waste management problems associated with plastics. These suggestions, for example, include the belief that landfill space will be preserved as plastic degrades in the landfill, and that aesthetic losses and risks of wildlife entanglement due to litter on land and in the marine environment will be reduced by the use of plastics that quickly degrade. Before we can be fully supportive of an increased use of degradable plastics we need to be sure that the degradation process occurs at a rapid rate in different environmental settings (e.g., cold water vs. warm water) and that clear environmental benefits result from their use. There do appear to be some specific beneficial uses for degradable plastics, including agricultural mulch films and bags used to

collect materials destined for composting. We cannot determine if these and other applications are appropriate with the current information.

Regarding proper municipal solid waste management, i.e., source reduction, recycling, incineration, and landfilling, EPA's analysis of existing information indicates that current degradable plastics technologies will not help to improve any of these management methods. The effect of degradables on each management method is described below.

- o Source Reduction: Degradable plastics do not play a role in source reduction because they do not reduce the volume or the toxicity of the waste generated.
- o Recycling: Recyclers and groups interested in increasing recycling, have expressed serious concerns about whether degradable plastics, when mixed with non-degradables which are processed for recycling, will contaminate the recycled foodstock and either disrupt the recycling process or make products containing recycled plastics less reliable. If this did occur routinely, it could actually reduce recycling by increasing the cost of recycling while reducing product reliability, thus discouraging continued participation by those who are involved in recycling plastics.
- o Incineration: As far as we are able to determine at this time, there would be little practical impact on

incineration resulting from increased use of degradable plastics.

- o Landfilling: Degradables will have little effect, if any, on landfill capacity. Although some 50% of the municipal solid waste we currently dispose of is already "degradable," studies have found that even items such as paper may remain intact for many years past closure of landfills. Thus any "additional" capacity gained through the use of degradable plastics would come far into the future. In addition, the degradation mechanism, to the extent that it ultimately works, may change the quality of the leachate in landfills, although we have not yet made a determination on whether this is the case.

Regarding improper management of waste (e.g.,littering), effects of increased use of degradables are uncertain. How individuals' behavior may change with knowledge that plastics are degradable cannot be readily determined. However, one of the serious concerns about litter, particularly in the marine environment, is the potential for entanglement and ingestion of plastics by wildlife. We are not certain how different degradables will perform in different environmental conditions (e.g., in water vs. on land; performance of photodegradables carried beneath the surface when covered by algae or seaweed). Nor are we convinced that if the plastic "degraded" into smaller pieces that the ingestion threat posed by many small remaining plastic fragments

is less significant than that posed by larger pieces of plastic.

These are some of the more important of our preliminary findings in the Report to Congress for purposes of this Committee's deliberations today. As you can tell from many of these statements, we still have a good deal to learn about the potential uses and misuses of degradable plastics. And we will be continuing to work with our colleagues both at EPA and in the other Federal agencies (Food and Drug Administration, National Institute of Standards and Technology, Department of the Navy, and the Department of Agriculture) who have played a significant role in the development of the Report, to answer some of these questions. I would be more than happy to provide you with a copy of the Report as soon as it is completed. Let me turn now to some of the efforts EPA is undertaking, and is aware that others are undertaking, to follow up on these unresolved questions.

Related Research Efforts

EPA's Office of Research and Development has initiated an effort to catalog and analyze current methods for measuring degradation of enhanced degradable plastics as the first step toward determining which measurement methods and which material properties perform best. The Office of Solid Waste, in conjunction with the Office of Research and Development, recently agreed to jointly fund two research projects. The first will be divided into two phases. The first phase will examine how effectively a variety of currently available products which are made of degradable

plastics actually degrade in a variety of environments - for example, are stabilizers and other additives released into the environment, or do small fragments only of the original materials remain which are not releasing degradation byproducts? The second phase of this study will evaluate the environmental impacts of the smaller pieces which remain in the environment, or of the releases of any degradation byproducts, should releases be shown to occur. The second research project will evaluate the impact of inserting currently available degradable plastics into existing recycling processes to determine whether either the machinery for recycling or performance of the end product is compromised. Work on these projects will commence as soon as we have established the workplans and evaluation protocols for the studies; we anticipate that this will be during the current fiscal year. In both of these efforts we are seeking industry support.

We are also aware of efforts underway by private organizations. For example, ASTM has recently formed a committee on degradable plastics which is attempting to formulate standards and testing methods for these materials. In addition, several developers of degradable plastics are organizing an international workshop on degradable plastic materials that will involve researchers from industry and the academic community. These efforts, and others, will help to increase available information and understanding of degradable plastics.

Once we have a majority of these fundamental questions addressed -- questions, which I stress, are essential to answer before we can evaluate the potential environmental impacts of increased use of degradable plastics -- we will be in a much better position to make a determination on whether, and for what uses, the Federal government should engage in encouraging this recent development.

Comments on S. 1237

As you are aware, J. Winston Porter, then Assistant Administrator for Solid Waste and Emergency Response at EPA, testified on a similar bill before this Committee last September. At that time he indicated the Reagan Administration's opposition to the bill in question, largely based on some of the same information gaps which I have discussed today.

Many of the provisions of the bill before us today for consideration are the same as those included in the bill on which Mr. Porter testified. And, many of the questions remain unanswered, although, as I have indicated in my remarks, we have made progress on these questions, and projects are being put in place which will continue to move us toward being able to respond fully to those questions which must be answered before we can support legislation encouraging the use of degradable plastics on a broad scale.

Although we support the overall goals of the bill, we believe it is premature to mandate or encourage increased reliance on

degradable plastics based on the information that is currently available to us. The bill contains important ideas to consider at a future date, and we would be happy to have discussions with the Committee and your staff regarding the progress we and industry are making toward resolution of these important questions along the way.

Mr. Chairman, this concludes my prepared remarks. I would be happy to respond to any questions that you or other members of the Committee may have at this time.

U.S. ENVIRONMENTAL PROTECTION AGENCY'S ANSWERS TO: SENATOR JOHN GLENN'S QUESTIONS FROM JULY 18, 1989 HEARING

Question 1: How do you propose to address the degradable plastic research needs identified by your initial studies without the benefit of legislation such as S.1237?

Answer: EPA has the authority under existing RCRA provisions to conduct the research needs to address the basic questions we have regarding the performance and potential environmental effects of degradable plastics. Therefore, we do not believe that additional legislation is needed to conduct and complete this research.

Question 2: Do you believe it is desirable to develop uniform definitions, standards, and methods of testing for degradable plastics?

Answer: Yes, EPA fully supports the efforts now underway at the American Society for Testing and Materials (ASTM). As you know, ASTM is a well respected, non-profit, standard setting organization. They have the experience and expertise to tackle this difficult project. The EPA, as well as other Federal agencies, will continue to participate in these efforts.

Question 3(a): Do you support the objectives of S.1237 regarding what factors should be considered when establishing degradable plastics standards?

Answer: Yes, we support the factors identified in S.1237. The rates of degradation in various environmental settings and conditions and consideration of the effects of degradables on human health and the environment are the primary critical types of data that are needed to determine if degradables are a "safe" alternative. It should be noted that these factors are very broad and capture a variety of situations and concerns. For example, identifying the effects on human health and the environment encompasses a great many potential impacts.

Question 3(b): Please identify other factors that should be considered when developing degradable plastics standards.

Answer: Other factors that should be considered before a determination regarding the usefulness of degradables can be made include:

-- the impact of degradable plastics on plastics recycling operations and other waste management options (e.g., landfilling).

-- the benefits and drawbacks of using degradable plastics instead of "non-degradable" plastics or instead of using other materials such as paper.

Question 4(a): For FY 1989, how much money and staff resources have been allocated to degradable plastic projects and programs? Provide itemized breakdown.

Answer:

Project	FY 1988 $$	FTE
Laboratory simulation of degradation in different environmental settings	$150K**	0.1
Research on impacts of recycling	$50K	0.1
Literature search on standards and definitions, state programs	$38K	0.1
General support for degradable plastics section in report to Congress	$20K	0.1

** This project will receive additional funding in FY 1990. We are also seeking industry and other Federal agency support for this project.

Question 4(b): For FY 1988, how much money and staff resources were spent on degradable plastic projects and programs?

Answer:

Project	FY 1988 $$	FTE
Support for degradable plastic section in report to Congress	$15K	0.1

Question 5(a): What are your views on the idea that composting could maximize use of degradable plastics to address the solid waste management problem?

Answer: EPA believes that a potential appropriate application of degradable plastic technologies is in bags that hold material (e.g., yard wastes) that is destined for composting. Our support of the use of degradable plastics in this or any application is dependent on results of research efforts.

The EPA is promoting composting of yard wastes because yard wastes are such a large component of the municipal solid waste stream (20% by weight). Collection of yard wastes for composting can take various forms. Some communities vacuum the material off of the street and therefore do not need bags for holding the material. However, other communities collect bagged yard waste from residents. Currently, if residents use plastic bags, operators at the compost facility must remove the plastic. If degradable plastics do not compromise the quality of the compost material, they may save time and money at composting facilities by reducing the time and labor needed to remove plastic bags.

Question 5(b): Could this method enhance or extend landfill capacity?

Answer: As explained above, composting could substantially reduce the amount of materials destined for landfills and therefore could extend landfill life. Degradable plastics may ease composting operations (as long as there is no adverse affect on compost quality) and make the operations more economical. We do not believe, however, that landfilling of degradable plastics will help extend landfill life. As was mentioned in EPA's testimony, more than half of the waste stream is degradable (i.e., paper, yard wastes, food waste) and yet we still have a landfill capacity shortage in many parts of the country. Making an additional segment of the waste stream degradable will not help reduce the landfill problem.

Question 6(a): Are you aware of methods, which were raised by OTA in their testimony, to minimize or avoid concerns that have been raised regarding degradables and plastics recycling?

Answer: EPA knows of some methods to aid the recycling process (e.g., rinsing the biodegradable material with acid before recycling), however, recyclers are concerned about the cost of this extra step and about the added acid waste produced. We have also heard other manufacturers of degradable plastics suggest separating degradables out from the recycling stream. Manual separation of plastic waste is a labor intensive and time consuming task. Unless an automated system can be developed, this may not be a practical method.

Question 6(b): Do you view the promotion of recycling and the expanded use of environmental-safe degradable plastics as mutually exclusive? Please explain.

Answer: Our research on the potential impacts of degradable plastics on plastics recycling should help us to better answer this question. We may be able to identify specific roles for degradable plastics that would not interfere with recycling operations because the items would not be recycled (e.g., compost bags, agricultural mulch films). As you know, recycling is an extremely important waste management option because it can help to reduce discards of waste and save energy and natural resources. It is, in fact, second only to source reduction in EPA's waste management hierarchy. Plastics recycling is just beginning and may be seriously threatened by concerns of contamination. Therefore, the potential negative interaction between degradables and recycling must be carefully considered.

Question 7(a): You cited a degradable bag collection program which was discontinued by the City of Greensboro. Why was the program terminated? Can we draw any conclusions or findings based on their experience?

Answer: In response to a question asked during the July 18, 1989 Hearing regarding the impacts of degradable plastic on plastics recycling, we provided an example of a recycler that had experienced problems with degradable plastics in his recycling operations. The recycler is Mr. Barry Appelget of Mountain Polymers located in Greensboro, North Carolina. Mr. Appelget recycles a variety of plastics (and other materials). He had been accepting post-consumer bags and commercial waste polyethylene film. Mr. Appelget bales the bags he receives and sells them to

manufacturers of agricultural and construction film. Two supermarkets in the Greensboro area have started to offer degradable plastic bags to their customers. Mr. Appelget accepted these bags along with "non-degradable" bags. Two of his customers complained that the films they made from the baled plastic that contained degradable bags did not have a long enough life span (i.e., they were degrading). Mr. Appelget estimated that not more than 5-10% of the baled bags were degradable bags. After these complaints, Mr. Appelget refused to accept all post-consumer bags. Please note that Mr. Appelget is continuing to recycle other plastics, thus the "program" has not been terminated.

This was meant as an example of the concerns that plastics recyclers have regarding degradable plastics. This example emphasizes the need for research in this area. We must be very careful not to adversely affect the new and growing technology for plastics recycling.

Question 7(b): OTA has suggested that such a program could be successful and beneficial if the degradable plastics were so identified, collected, and taken to a proper disposal site. Were these procedures used by the City of Greensboro?

Answer: As mentioned above, Mr. Appelget, who is a private recycler, accepted the degradable bags along with other plastic bags. Mr. Appelget indicated that it would not be cost-effective at this time to try to manually separate degradable bags from other bags. Instead, he will no longer accept any kind of post-consumer plastic bag.

Question 7(c): How do you compare the Greensboro experience with other on-going programs such as in Lansing, Michigan and Urbana, Illinois?

Answer: These programs are not comparable. The Greensboro experience involved a private plastics recycler whose primary task is to provide high quality plastics to his customers. The Lansing, Michigan and Urbana, Illinois programs that we are familiar with are both pilot projects using degradable bags in a yard waste composting programs.

Question 8: In your testimony, you mentioned that EPA is working with private industry to determine the rate and type of degradation that occurs in various environments and also to ascertain the impact of mixing degradable plastics with recycled materials. Which companies are you working with and how are they assisting your effort?

Answer: I was referring to the first two research initiatives described in answer to Question 4(a) which we only recently began planning and setting up. During the development of the report to Congress, we made contact with some of the major manufacturers and developers of degradable plastics in order to get the most up-to-date information on degradable plastics. We would like to work with industry on upcoming research efforts. Our research and development office has done this in the past for other programs. At this time, we are just initiating our research program in degradables. We will be seeking industry support and input once we have developed more specific research plans. Our research and development office also has been in contact with some manufacturers and suppliers of degradable plastics. Some of them have offered to supply us with material for testing and work with us on research efforts.

NIST UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY

U.S. DEPARTMENT OF COMMERCE

STATEMENT OF LYLE H. SCHWARTZ, DIRECTOR

INSTITUTE FOR MATERIALS SCIENCE AND ENGINEERING

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

BEFORE THE COMMITTEE ON GOVERNMENTAL AFFAIRS

UNITED STATES SENATE

ON THE "DEGRADABLE COMMODITY PLASTICS PROCUREMENT ACT"

JULY 18, 1989

Mr. Chairman and Members of the Committee:

I am Lyle Schwartz, Director of the Institute of Materials Science and Engineering at the National Institute of Standards and Technology (NIST). With me today is Dr. Leslie Smith, Chief of the Polymers Division at NIST. I am here to summarize the views of the Department of Commerce with regard to S. 1237, the Degradable Commodity Plastics Procurement Act of 1989.

We recognize that the problems associated with the disposal of solid waste, of which plastics are an increasing fraction, are becoming more serious as landfill sites are being used up. However, although the percentage of plastics in solid wastes nearly doubled between 1976 and 1984, it still represents only a small percentage of the total volume of wastes. The discarding of plastics

in our oceans and streams and the littering of the land is a serious threat to fish and wildlife, as well as being an eyesore.

The concept of plastics which will degrade much more rapidly when exposed to the environment is certainly worth considering. Up to this time, however, there has been little research performed on the various issues associated with the production, use, and disposal of degradable plastics. Both photodegradation which occurs due to exposure of the plastic to ultraviolet light, and biodegradation involving the use of microorganisms which release enzymes which in turn can disintegrate natural polymers such as corn starch, are possible methods of plastic degradation. Photodegradable technology is highly developed, being used in beverage rings, agricultural mulch film, and trash bags. Photodegradable polymers suffer from two problems, 15-20% greater cost than the non-degradable version, and difficulty in the control of photodegradation onset.

One method of creating biodegradable plastics is by adding corn starch to polymers. In one patented process, starch is added to petroleum-based polymers at levels of 7-15% by volume. The U.S. Department of Agriculture has developed a process in which 40-60% starch is added to polyethylene plus a complex chemical. Films produced by this latter technique have been reported to be transparent, flexible and self-supporting. In an entirely different process, more complex polymers can be created which are degradable by bacteria such as penicillum strains.

In order to develop and make use of degradable plastics, much more research remains to be done on the properties of the plastic itself, the degradation

mechanisms, and the degradation products. Standard test procedures must be developed. Such standard tests will require knowledge regarding the type of degradation, and in the case of biodegradation, the type of microorganisms to be used (i.e. marine, freshwater, soil), the composition and shape of test specimens, testing conditions (e.g., exposure time, temperature, composition of the test medium), and definitions and measurements of the degradation itself. Other degradation methods such as photodegradation will require similar test development.

NIST scientists are currently conducting a modest program aimed at identifying the critical issues in the biodegradation of starch/polymer plastics in air. The reproducibility of biodegradation test procedures, involving a standard mix of fungi developed through ASTM, is being studied using well characterized materials supplied by the Department of Agriculture. NIST scientists are also working closely with ASTM Subcommittee D20.96 on Environmentally Degradable Plastics. NIST has also acted as a consultant to EPA and NOAA, assisting in the preparation of reports on degradable plastics.

There have been a number of questions raised whether degradable plastics are the best possible solution to the waste disposal problem. For instance, a recent New York Times article (April 11, 1989) quotes various sources who question both the effectiveness as well as possible environmental hazards associated with degradable plastics. One concern expressed was that toxic ingredients in plastics, including heavy metals such as cadmium and lead, used as pigments and stabilizers, would be released by degradation. The possibility of the migration of chemical species from the plastic to food items contained by them must be considered.

In addition, the extensive use of degradable materials could interfere with current efforts in plastic recycling.

At this time we have insufficient knowledge of the mechanisms of plastic degradation, and the possible effects on the environment of the degradation products, to be able to write effective test standards. More research is needed to determine the kinds of test procedures that will be required, both for photodegradable as well as biodegradable plastics. It will not be possible to develop standards in the twenty-four months indicated in S. 1237. It typically requires 3 to 5 years for standards to be developed through organizations such as ASTM, even with technologies more mature than this one. Until such time as more is known regarding possible environmental hazards of the degradation products, we believe that requiring federal agencies to increase the use of degradable plastics is not advisable. In addition, more information will be needed to make decisions regarding the choice of biodegradable or photodegradable material for a particular application.

In summary, before any action - including this legislation - is taken regarding increased governmental purchase of degradable plastics, industry should demonstrate that these materials do not pose an environmental risk or interfere with efforts to recycle certain plastics.

At the same time research into the use of biodegradable plastics should be expanded. The Federal research effort should be coordinated throughout the Federal Government, with the ultimate goal being the generation of measurement standards, which if the materials appear useful, can be employed to aid in

Thank you Mr. Chairman. I will be happy to address any questions you or the Subcommittee may have.

EC/V.N.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
(formerly National Bureau of Standards)
Gaithersburg, Maryland 20899

AUG 30 1989

Honorable John Glenn
United States Senate
Washington, D.C. 20510-6250

Dear Senator Glenn:

Our response to questions for the record regarding testimony at the Governmental Affairs Committee Hearing on S. 1237, The Degradable Commodity Plastics Procurement and Standards Act, are enclosed. We appreciate the opportunity to comment on the issues surrounding degradable plastics and on this specific legislation.

We would be pleased to provide any further information on these matters.

Sincerely yours,

Lyle Schwartz

L. H. Schwartz
Director
Institute for Materials
Science and Engineering

7 Enclosures

1. You mentioned in your testimony that the federal research effort on degradable plastics should be coordinated throughout the federal government. A report released at my request last year by the General Accounting Office (GAO) reached a similar conclusion.

   Who should take the lead in coordinating these federal activities? Which federal agencies should be involved in this effort?

   Degradable plastics are primarily promoted as part of a solution to the problem of municipal solid waste. The Environmental Protection Agency is the mission agency in this area and has studied the overall solid waste program. The EPA would therefore seem to be the appropriate agency to coordinate federal activities. We suggest that other federal agencies that should be involved include:

   Agriculture (food-based degradable plastics)
   NOAA (marine pollution)
   NIST (standards and test methods)
   DOC/ITA/Trade Development (responsibility for commercialization of resource recovery technologies per RCRA)
   Navy (disposal of plastics at sea)
   Energy (recycling and conservation)

2. You stated that the "extensive use of degradable plastics could interfere with current efforts in plastic recycling".

   What tests or studies have you conducted showing that degradable plastics may interfere with recycling efforts?

   NIST has not conducted any tests of the effect of degradable plastics on the processing or properties of recycled plastics. Our statement regarding possible interference with recycling efforts is based on knowledge of current recycling programs.

   There is an inherent difference in the design philosophy between a degradable material and most fabricated products. A commercial product must have a <u>reliable and predictable</u> useful lifetime. The costs of premature failure are high so successful products are made of plastics whose properties are well known and whose performance in the use environment is stable. Degradable plastics, on the other hand, are specifically designed to be unstable under certain conditions. Mixtures of degradable and durable plastics will most likely have variable performance which could dramatically alter the market value of recycled products.

3. **Testimony from the Office of Technology Assessment (OTA) referred to methods available to minimize or avoid concerns which have been raised on the effects degradable plastics may have on recycling.**

   a) Are you aware of these methods?

   b) Do you view the promotion of recycling and the expanded use of environmentally-safe degradable plastics as being mutually exclusive? Please explain.

There are many possible ways to mitigate the effects of degradable plastics on recycling efforts but we are not aware of any which could be widely applied at low cost. For example, degradable plastics could be confined to films such as trash bags or flexible packaging which would not be recycled and could be easily separated from waste streams containing other plastic products. This approach may be desirable but would limit the use of degradable plastics to applications that have very small volume in municipal waste.

Another possibility is that mixed waste could be composted to remove the degradable plastic from the waste stream before recycling the remaining plastic. This additional treatment and handling would certainly add to the cost of recycling.

There is no doubt that useful products can be made from some mixtures of degradable and durable plastics. The possibility that a waste stream would contain such a mixture does present additional separation or measurement costs to the recycler. If the waste stream were to contain mixtures of different types of degradable plastics, based on different degradation chemistry, the complexity of separation and processing would rise greatly and the recycled products would likely have diminished useful properties.

The expanded use of degradable plastics and promotion of recycling may not be mutually exclusive but they inherently demand compromises. Large amounts of degradable plastics in the waste stream will add to separation and processing costs and may limit the market value of the recycled products. These costs may be offset by other benefits but such a conclusion could only come from a comprehensive analysis of the entire solid waste system. We can only comment on the scientific and technical aspects of the material properties and processes associated with recycling. From this standpoint, the presence of degradable plastics in the waste stream definitely complicates recycling.

4. In S. 1237, degradable plastic standards and testing procedures would have to take into account how long and under what conditions products degrade, and what, if any are the effects on human health and the environment.

   a) Do you support this objective?

   b) Please identify any other factors which should be considered in developing degradable plastic standards and testing procedures.

We certainly agree that reasonable standards and test methods for degradable plastics should be quantifiable, relevant to the actual conditions found in disposal, and capable of demonstrating the safety of any environmental effects.

We do wish to emphasize that these are not easy conditions to satisfy and significant time and technical effort will be needed to accomplish these objectives.

5. Can there be a commercial market for degradable plastic products-- such as the prototype items I displayed at the hearing-- in the absence of uniform standards?

Commercial markets can and often do develop in the absence of uniform standards but those markets are not necessarily efficient. In the absence of standards, ineffective products can displace good ones and market uncertainties can inhibit development of improved products.

6. S. 1237 would require the federal government to take advantage of private sector expertise and research through consultation and cooperation in developing uniform standards and testing procedures for degradable plastics. Is that a viable approach?

NIST conducts many of its research programs in close cooperation and consultation with private industry. Such an approach in developing standards and test procedures for degradable plastics is not only viable but highly desirable. The voluntary standards system uses a balanced representation of producers, users, and representatives of the public interest in achieving consensus standards.

7. For FY'89, how much money and staff resources (personnel) has NIST allocated to degradable plastic projects and programs? How much money and staff resources were allocated in FY'88? Please provide an itemized breakdown.

Our estimates of NIST resources allocated to degradable plastic projects are as follows:

FY 88 - 0 FY 89 - $40K, 0.3 staff years

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

STATEMENT BY

L. ROBERT LAKE

DIRECTOR, OFFICE OF COMPLIANCE

CENTER FOR FOOD SAFETY AND APPLIED NUTRITION

FOOD AND DRUG ADMINISTRATION

PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH AND HUMAN SERVICES

BEFORE THE

COMMITTEE ON GOVERNMENTAL AFFAIRS

UNITED STATES SENATE

JULY 18, 1989

FOR RELEASE ONLY UPON DELIVERY

Mr. Chairman,

I appreciate the opportunity to testify today on S. 1237, the "Degradable Commodity Plastics Procurement Act of 1989". This bill would direct the General Services Administration (GSA) to promote the development of degradable plastics technology through an interagency council and encourage the procurement by Federal agencies of products made with such technology. The bill would also direct FDA to perform an assessment of the safety of indirect food additives intended to increase the degradability of plastic food packaging materials.

The disposal of solid waste is a national problem and we laud efforts to develop solutions. Numerous solutions to the management of plastic solid waste are being explored, such as recycling, degradability, and even incorporating food as packaging which can be consumed. Because of the diversity of polymers and of their end uses, a variety of solutions may be appropriate and viable. What is important is that various efforts be integrated into an overall solid waste management strategy that deals with all aspects of the solid waste problem effectively. We support EPA's Agenda For Action, which proposes such an integrated solid waste management strategy.

Clearly, government has a role to play in the development, as well as evaluation, of various technologies, particularly when incentives in

the private sector are lacking or in conflict. FDA's mission is to ensure the safety and effectiveness of the products it regulates. I believe it wholly consistent with that mission to undertake or fund applied research into technologies that may be used in products which FDA will have to regulate. Such applied research not only can enhance the development of the technology, but also enhances our ability to perform high quality safety evaluations when presented with a product of that technology. It also can produce savings of time and resources for the American health care industry and the public generally. For example, the Agency's investment in research on the bio-availability of dextran sulfate, a potential AIDS drug, led to savings of costs associated with unnecessary clinical trials when it revealed that the drug was not efficiently absorbed into the bloodstream.

In addition, FDA is committed to environmental protection and, within its purview, acts to minimize or avoid negative environmental impacts which may result from the products it regulates. In accordance with the National Environmental Policy Act of 1969 (NEPA), environmental impact consideration has become an integral part of FDA's regulatory process. The environmental review begins when FDA identifies a problem that requires action by the agency under the statutes it administers, or when FDA receives an environmental assessment (or a claim that an exclusion applies) from an applicant or petitioner. FDA's assessment of environmental factors includes the identification of the parts of the

environment that may be affected by the action, the evaluation of pertinent environmental data, and the consideration of alternatives. Based on this assessment, FDA determines whether an action will have significant environmental effects and require the preparation of an environmental impact statement. FDA takes steps to ensure that environmental information is available to the public before decisions are made about actions that may significantly affect the quality of the human environment. For example, the Agency is preparing an environmental impact statement for its proposed action to establish the safe conditions of use of vinyl chloride polymers (PVC), including the potential effects of PVC on post-consumer recycling programs.

The Bill

S. 1237 would direct the GSA Administrator to:

- promote development of degradable plastics technology by preferential procurement of such products, with emphasis on agricultural commodity-based products;

- establish an interagency council (of which FDA is a co-chair) to coordinate implementation of this Act, encourage use and development of such products and develop uniform definitions, standards and testing methods; and

- ensure that such products meet safety and environmental concerns.

The bill also would require that FDA perform an assessment of the safety of indirect food additives intended to increase the degradability of plastic food packaging materials.

I will defer to GSA on the overall merits of the bill and to EPA on associated environmental issues. I will confine the remainder of my remarks to FDA's food additive concerns regarding degradable plastics technology.

The Food Additive Petition Process

Under section 201 of the Food, Drug, and Cosmetic Act, a "food additive" is defined as, "any substance the intended use of which results or may be reasonably expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food (including any substance intended for use in producing, preparing, treating, packaging, transporting, or holding food; and including any source of radiation intended for any such use), if such substance is not generally recognized among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures (or, in some cases

experience based on common use in food) to be safe under the conditions of its intended use."

Under section 409(b) of the Food, Drug and Cosmetic Act, any person may file a petition proposing the issuance of a regulation prescribing the conditions for which a food additive may be safely used. The food additive petition must include: the additive's identity; the amount of the food additive proposed for use and the purposes for which it is proposed; its functional effect; a description of the methods used to determine the amount of the additive in the food or of any substance formed in the food because of its use; reports of investigations made regarding the additive's safety; proposed tolerances for the additive if necessary; and an environmental assessment. Within 15 days after receiving the petition, FDA will notify the petitioner as to whether the petition has been accepted for filing. Within 30 days of filing, the Agency will publish in the Federal Register a notice of the filing, the name of the petitioner, and a brief description of the petition in general terms.

Some examples of direct food additives include: calcium silicate used as an anticaking agent in food and baking powder; polysorbates used as emulsifiers; and Aspartame used as a sweetening agent. Indirect additives include polyethylene, cellophane, and nylon resins which are used to make food packages. Direct food additives are intentionally added to food, whereas indirect food additives become components of the

food because of their migration or the migration of their components from food contact surfaces.

Food additive petitions are submitted to FDA's Center for Food Safety and Applied Nutrition. After administrative and scientific evaluation of a petition and supporting data, FDA will publish in the Federal Register a regulation prescribing the conditions under which the food additive may be safely used. The FDA may also propose a regulation amending or repealing a food additive regulation if a petition contains data supporting such a change.

Areas of Concern Regarding S. 1237

S. 1237 would require FDA to perform an assessment of the safety of food additives intended to increase the degradability of plastic food packaging materials. However, there is currently a lack of very basic information underlying this technology which is critical to a safety review. It is essential to know the identities of substances which may be added to plastic in order to make it degradable, their toxicological significance to humans and how these substances affect polymers in order to impart degradability. Product characteristics which would need to be evaluated include the comparable long-term integrity of the package, whether it might be susceptible to bacterial and fungal growth, and the potential for migration of substances from a food

package to the food within.

To effectively evaluate the environmental impact, as required under NEPA, of use of degradable food packaging and any food additives that might impart degradability to plastic food packaging, information is needed on (1) whether a polymer is degradable and, if so, under what conditions and in what time frame; (2) the potential for increased environmental introduction of degradation products and additives from a degrading polymer; (3) the potential effects of small pieces of the degrading polymer in terrestrial and aquatic ecosystems; and (4) the impact of degradable polymers on recycling programs.

Normally, FDA's role in the food additive petition process is to perform an independent, objective review of data submitted by sponsors on the safety of additives and their effect on the environment. In the absence of a sponsor, however, our role could perhaps be enhanced to include advising industry on the directions reseach efforts must take to resolve our concerns or, with a greater expenditure of resources, funding the necessary research. However, our credibility as a scientific agency depends on our being unbiased reviewers and not advocates for any specific technology or material.

Therefore I must clarify that FDA's participation in the research on

this or any technology will not compromise our objectivity in the subsequent safety evaluation of products of the technology.

I must also stress that any enhanced role for FDA will require a reconsideration of current resource allocations. Various financing options would need to be developed within the Administration and discussed with Congress at the appropriate time. Otherwise, FDA would have to divert resources from current petition review activities, slowing down decisionmaking and the introduction of new, beneficial food additives.

Conclusion

As I stated earlier, FDA supports efforts to alleviate this pressing environmental problem and we are anxious to work with you to develop solutions. With respect to the legislation under consideration, we defer to GSA and EPA. Thank you for giving me the opportunity to express my views.

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DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

The Honorable John Glenn
Committee on Governmental Affairs
United States Senate
Washington, D.C. 20510-6250

OCT 04 1989

Dear Senator Glenn:

This is in response to your letter of July 31, 1989, in which you requested answers to five questions regarding Mr. Lake's recent testimony at the Governmental Affairs Committee Hearing on S. 1237, The Degradable Commodity Plastics Procurement and Standards Act.

For convenience, we have listed your questions with responses to each question.

Question

1. You stated that FDA needs additional information on degradable plastics in order to respond to the safety issue of food additives. You further testified that FDA's participation in such a research effort must remain "objective."

   In what specific ways do you think S. 1237 -- which requires FDA to conduct an assessment on the safety aspects of degradable plastics used in food packaging -- might compromise your objectivity?

Answer

Traditionally, a party who wishes to use or promote the use of a food additive is responsible for sponsoring its own research and for compiling the data and information needed to demonstrate that the additive is safe, will have its intended technological effect and its use will not have a significant impact on the environment. The Federal Food, Drug, and Cosmetic Act requires that these data and information must be submitted to FDA, in a food additive petition, for agency approval before the additive may be used. FDA's role, upon receipt of the petition, has been to conduct an independent, unbiased evaluation of the information submitted in support of the requested use of the additive, and, if the data support it, to issue a food additive regulation for the use.

Mr. Lake was simply expressing FDA's desire to maintain its traditional role as an unbiased evaluator of food additive petitions. Direct FDA involvement in developing data presents some potential problems. First, if FDA employees worked with individual companies to develop data, questions might be raised about whether those employees could fairly judge data submitted by those companies. Second, questions might also be raised about the ability of FDA employees to fairly judge data that they themselves developed. We also note that FDA's reputation for objectivity could be damaged if the agency is perceived as a proponent of any specific packaging technology over others. Nevertheless, if legislation were to require us to conduct research and evaluate the safety of food packaging formulations, the Agency would of course, make a good faith effort to comply.

Question

2. You stated that you cannot complete an assessment on degradable products used for food packaging without a specific petition. Yet, FDA has authority under the Federal Food, Drug, and Cosmetic Act to examine how food and beverage products interact with materials and to assess human health risks.

   a) Does FDA have the resources and expertise to conduct preliminary research and assess additives which are already being used to make generic biodegradable items, like the food wraps and beverage containers displayed at the hearing? Please explain?

Answer

As indicated in response to question 1, FDA usually examines potential human health risks from food packaging when it evaluates food additive petitions that specify the exact formulation of the material, including its purity, and also contain a clear statement of how it will be used. This evaluation is based almost exclusively on a review of data and information submitted by industry petitioners. Without precise information on what people will be exposed to, and without knowing the level of exposure, we cannot conduct an adequate safety evaluation. We do not generally have the means to develop this information.

In addition, while FDA does have a small packaging laboratory (2 chemists, 1 technician, and 1 supervisor), people who work in our laboratories do not have any particular expertise in degradable packaging materials. They provide laboratory support for our petition reviewers, enabling us to verify some of the data submitted by petitioners. They also provide an investigative capability, enabling us to identify violations of regulations. We also do not have any existing laboratory capability to generate or verify data on the environmental impact of packaging materials. Finally, we do not have any knowledge of the commercial use of degradable food packaging materials at this time.

Although we do not have safety concerns about the use of food grade starch in packaging, we would be concerned about the use of unapproved polymers and any chemical components that may be used to enhance or initiate degradation. The safety and environmental impact of these chemicals and associated packaging would have to be evaluated by FDA, under food additive provisions of the Federal Food, Drug, and Cosmetic Act and under the National Environmental Policy Act, before they could be lawfully used in food packaging.

Question

b) Would FDA need additional authority to carry out such an assessment?

Answer

To the extent that an assessment includes the conduct of research or the development of safety and environmental data that will be used to gain food additive clearance for the use of degradable chemicals, FDA will certainly need additional resources. Also, we have often been requested to conduct research that will assist in the development of new products, or will assist specific companies, particularly small businesses, with their individual data requirements. We have always denied these requests. A specific legislative mandate could justify providing assistance with this technology and not in other cases, including competing photodegradable and recycling technologies.

Question

3. How long do you anticipate it would take FDA to approve a petition submitted for a degradable plastic product which is to be used in food packaging?

Answer

The total lapsed time to approve a food additive petition for a degradable plastic product is subject to many variables and cannot be predicted. FDA is mandated by law to complete each cycle of its review within six months. However, if a petition does not contain sufficient data and information to support the requested use, the petitioner may be required to conduct additional studies. The time needed to complete the studies, and the additional time needed by FDA to evaluate them (perhaps a new 6-month cycle), could cause the total lapsed time to be several years. Based upon our experience in dealing with companies that are knowledgeable regarding petition requirements, the average lapsed time for approval of a petition for a packaging material has been 14 months. A petition for a degradable material could, however, take longer because this is a new technology that is unfamiliar to us and to prospective petitioners.

Question

4. How long did it take FDA to approve the styrofoam packaging now being used commercially by the fast-food industry and supermarkets?

Answer

Styrofoam (polystyrene) was used as a food packaging material before the 1958 Food Additives Amendment became law. FDA approved petitions for the basic polymer and nearly all of the many adjuvants used to make foamed beads, and to mold the beads into packaging containers, within the first five years following passage of the 1958 law. Although the use of styrofoam containers has expanded greatly during the intervening 25 years, there have been few changes in this technology which have required new FDA food additive approvals.

Question

5. What staff resources (funding and personnel) did FDA allocate in FY-89 for degradable plastic programs and projects? What staff resources were allocated in FY-88? Please provide an itemized breakdown.

Answer

No staff resources were specifically allocated for degradable plastics programs during FY-88 or FY-89. Although we have met with interested companies, the total time spent in this particular area has been relatively small. These limited resources are part of our overall planned time for "food additive petition reviews," which encompasses many different types of food packaging technology. In FY-89, 19.7 person years were allocated for food additive petition reviews for food packaging materials; in FY-88, 19.1 person years.

I hope the above responds adequately to your questions. Please let me know if there is any additional information you need.

Sincerely yours,

Hugh L. Cannon
Associate Commissioner
for Legislative Affairs

PREPARED STATEMENT OF JOSEPH G. O'GRADY
PRESIDENT OF ASTM

BEFORE THE
COMMITTEE ON GOVERNMENTAL AFFAIRS

UNITED STATES SENATE
WASHINGTON, D.C., JULY 18, 1989

SENATOR GLENN AND MEMBERS OF THE COMMITTEE:

I AM JOSEPH G. O'GRADY, PRESIDENT OF ASTM. WITH ME TODAY IS DR. RAMANI NARAYAN, THE CHAIRMAN OF ASTM'S SUBCOMMITTEE D20.96 ON ENVIRONMENTALLY DEGRADABLE PLASTICS. ASTM, FORMERLY KNOWN AS THE AMERICAN SOCIETY FOR TESTING AND MATERIALS, IS ONE OF THE LEADING STANDARDS ORGANIZATIONS IN THE WORLD FOR THE DEVELOPMENT OF VOLUNTARY CONSENSUS STANDARDS FOR MATERIALS, PRODUCTS, SYSTEMS, AND SERVICES. ITS 134 STANDARDS WRITING COMMITTEES PUBLISH SOME 8,500 STANDARDS ANNUALLY. THESE STANDARDS MEET THE NEEDS OF INDUSTRY, GOVERNMENT, ACADEMIA, TESTING AGENCIES, AND THE SERVICE SECTORS OF OUR ECONOMY. THE ASTM COMMITTEES COVER A WIDE SPECTRUM OF SUBJECTS WHICH INCLUDE FERROUS AND NON-FERROUS METALS, CERAMICS, WASTE DISPOSAL, PLASTICS, CONSTRUCTION MATERIALS, PETROLEUM, TEXTILES, FIRE STANDARDS, MEDICAL SERVICES, BIOTECHNOLOGY, AND CONSUMER PRODUCTS. THESE STANDARDS ARE, IN MANY INSTANCES, THE PREFERRED DOCUMENT FOR TRADE. SINCE ITS FORMATION IN 1898, ASTM HAS EXPANDED TO INCLUDE SOME 32,000 MEMBERS, OF WHICH OVER 4,500 ARE INTERNATIONAL.

ASTM IS A MANAGEMENT SYSTEM FOR STANDARDS DEVELOPMENT THAT SERVES BOTH PRIVATE AND PUBLIC INTERESTS. IT IS A SYSTEM THAT WORKS WELL, IS NOT DOMINATED BY AN SINGLE INTEREST GROUP, AND IS ONE OF THE BEST EXAMPLES OF GOVERNMENT AND NON-GOVERNMENT SECTORS WORKING TOGETHER.

ALTHOUGH ASTM, A NON-PROFIT SOCIETY, CANNOT SUPPORT NOR OPPOSE LEGISLATIVE INITIATIVES, WE DO APPRECIATE AND SUPPORT THE SENSE OF S.1237, AS IT ADDRESSES A FUNDAMENTAL AND CRITICAL ENVIRONMENTAL PROBLEM. WE MUST ALSO REFRAIN FROM SCIENTIFIC OR ADMINISTRATIVE JUDGMENTS CONCERNING THE EFFICACY OF THE PROPOSALS CONTAINED IN THIS BILL. WE WILL, THEREFORE, LIMIT OUR COMMENTS TO THOSE PORTIONS OF THE BILL THAT CONCERN THE DEVELOPMENT OF STANDARDS AND TESTING PROCEDURES.

ASTM COMMITTEE D20 HAS BEEN ADDRESSING STANDARDS NEEDS FOR THE PLASTICS INDUSTRY FOR OVER 50 YEARS. IT HAS DEVELOPED CLOSE TO 400 STANDARDS, AND HAS 750 MEMBERS.

ASTM SUBCOMMITTEE D20.96 ON ENVIRONMENTALLY DEGRADABLE PLASTICS WAS FORMALLY ORGANIZED ON MARCH 15, 1989. ATTACHED TO THIS TESTIMONY ARE THE MINUTES OF THE VARIOUS MEETINGS OF D20.96. THE SCOPE OF THIS SUBCOMMITTEE IS "THE PROMOTION OF KNOWLEDGE AND THE DEVELOPMENT OF STANDARDS FOR PLASTICS WHICH ARE INTENDED TO ENVIRONMENTALLY DEGRADE." THERE ARE FOUR SECTIONS TO D20.96 WHICH DEAL WITH THE DIFFERENT CLASSIFICATIONS OF DEGRADABILITY. THEY ARE: BIODEGRADABLE, PHOTODEGRADABLE, CHEMICAL DEGRADABLE, ENVIRONMENTAL FATE (ESTABLISHING THE STANDARD PROCEDURES FOR DETERMINING THE BY-PRODUCTS OF DEGRADATION AND THEIR FATE IN THE ENVIRONMENT) AND A SECTION ON TERMINOLOGY.

THIS SUBCOMMITTEE ON ENVIRONMENTALLY DEGRADABLE PLASTICS AND ITS FIVE SECTIONS ARE COMPRISED OF MEMBERS REPRESENTING THE PLASTICS INDUSTRY, VARIOUS GOVERNMENT AGENCIES INCLUDING THE EPA, USDA, U.S. ARMY, NIST, U.S. NAVY AND THE GSA. ACADEMIA IS REPRESENTED, AS WELL AS AGRICULTURAL ORGANIZATIONS SUCH AS THE NATIONAL CORN GROWERS ASSOCIATION, IOWA CORN PROMOTION BOARD AND CORN GROWERS IN NORTH CAROLINA.

AS YOU CAN SEE, MANY OF THE GOVERNMENT AGENCIES THAT WOULD COMPRISE THE PROPOSED INTERAGENCY COUNCIL HAVE REPRESENTATIVES ALREADY INVOLVED IN THE ASTM STANDARDS-SETTING PROCESS. WE MIGHT ADD HERE, HOWEVER, THAT MISSING FROM THE GOVERNMENT-PROPOSED BODY ARE THE DIRECT CONTRIBUTIONS OF THE OTHER AREAS OF INTEREST AND EXPERTISE.

IF IT WERE DETERMINED THAT ASTM SHOULD HAVE INPUT INTO THE INTERAGENCY COUNCIL IN SOME SORT OF CONSULTATIVE CAPACITY, I WOULD BE PLEASED, OF COURSE, TO APPOINT AN APPROPRIATE PERSON TO BE AVAILABLE FOR MEETINGS, TO GIVE UPDATES ON THE ACTIVITIES OF D20.96 AND TO RENDER WHATEVER APPROPRIATE SERVICES ARE REQUESTED.

I CANNOT LEAVE THIS COMMITTEE, HOWEVER, WITHOUT MAKING THE FOLLOWING POINT: THE SOVEREIGNTY OF GOVERNMENT IN CERTAIN AREAS IS A PRINCIPLE ASTM HAS ALWAYS RESPECTED AND UPHELD. RESPONSIBILITY IN MATTERS OF HEALTH, SAFETY, THE ENVIRONMENT, AND THE ORGANIZATION AND STRUCTURE OF DEPARTMENTS IS CLEARLY A MATTER OF PUBLIC MANAGEMENT AND AUTHORITY.

OUR HISTORY IS RICH AND FULL WITH COLLABORATIONS WITH THAT SOVEREIGNTY FOR THE GOOD OF THE AMERICAN PEOPLE. THERE ARE INSTANCES, TOO NUMEROUS TO MENTION, OF GOVERNMENT INITIATIVES SUPPORTED BY THE TECHNICAL RESOURCES OF OUR FULL CONSENSUS SYSTEM. WE CANNOT LEAVE YOU IN GOOD CONSCIENCE WITHOUT OFFERING IT TO YOU NOW IN THE PLACE WHERE IT HAS NO PEER; THE DEVELOPMENT OF DEFINITIONS, STANDARDS, AND TESTING PROCEDURES.

WE, THEREFORE, ASK YOU TO CONSIDER THE BENEFITS OF A STANDARDS DEVELOPING SYSTEM THAT IS CAPABLE OF ABSORBING ALL INTERESTED GOVERNMENT AGENCIES, OF ADDING TO THE WEALTH OF COLLECTIVE TECHNICAL AND PRACTICAL WISDOM FROM THE OTHERS WHO MUST BE PARTNERS IN THE RESULT, OF THE ADMINISTRATION OF PRUDENT, TRANSPARENT, AND RIGOROUS MANAGEMENT, AND WHICH WILL PRESENT IN THE END A BALANCED RESULT, BOTH IN SCIENCE AND IN SOCIAL ASPECTS.

WE SUGGEST TO YOU THAT IT IS EASIER IN THE END TO IMPLEMENT A PRACTICE THAT HAS INHERENT IN IT THE EXPERIENCE AND THE LOYALTIES OF THOSE OF WHOM IT WILL BE REQUIRED.

I WOULD LIKE TO THANK YOU, SENATOR GLENN, FOR HOLDING A HEARING ON SUCH AN IMPORTANT TOPIC. I SINCERELY HOPE THAT THE WORK AND EXPERIENCE OF ASTM WILL BE OF SOME BENEFIT TO YOU, THE COMMITTEE AND TO THE SUCCESSFUL RESOLUTION OF A PROBLEM THAT IS SO VITAL TO THE HEALTH OF THIS PLANET. I WOULD BE HAPPY TO ANSWER ANY QEUSTIONS. I WILL, OF COURSE, RELY ON DR. NARAYAN FOR TECHNICAL RESPONSES.

PRESIDENT

JOSEPH G. O'GRADY
ASTM
1916 Race Street
Philadelphia, Pennsylvania 19103
215/299-5555

Joseph G. O'Grady, president of ASTM, is a native of North Bergen, New Jersey. He received a B.E.E. degree in 1954 from the College of Engineering of New York University.

O'Grady joined the ASTM staff as executive vice president in January 1984. He assumed its presidency in June 1985. Prior to this, O'Grady served as vice president of the PSE&G Research Corporation, a wholly owned subsidiary of Public Service Electric and Gas Company of New Jersey, and directed the activities of the corporate Research and Testing Laboratory in Maplewood, New Jersey.

During his tenure at PSE&G, O'Grady served as a volunteer member of ASTM on several technical committees, including those on petroleum and atmospheric analysis. He was elected to ASTM's Board of Directors in 1973 and served as its chairman during 1978-79.

O'Grady served on the National Executive Committee of the Consultative Council of the National Institute of Building Sciences from 1981 to 1985, and is currently serving as a member of the Board of Directors of the institute. He also serves as a director of the Materials Property Council and is a member of the Industry Functional Advisory Committee on Standards, which is jointly sponsored by the U. S. Department of Commerce and the Office of the U. S. Trade Representative. He was also recently appointed Executive Director of the Institute for Standards Research, a subsidiary of ASTM.

A registered professional engineer in the state of New Jersey, O'Grady is a member of the National Association of Corrosion Engineers, the Standards Engineering Society, the Council of Engineering and Scientific Society Executives, and the Newcomen Society. He is a past director of the American Association of Laboratory Accreditation and past chairman of the Executive Advisory Committee of the Codes and Standards Committee of the Edison Electric Institute.

AGENDA
SUBCOMMITTEE D20.96
ENVIRONMENTALLY DEGRADABLE PLASTICS
RED LION INN, SALT LAKE CITY, UTAH
WEDNESDAY, JULY 12, 1989
8:00 A.M. - 5:00 P.M.

1. Call to Order

2. Self Introductions of Attendees

3. Review of Organizational Meeting and Action Items Accomplished to Date

4. Review of Items to be Covered at Section Meetings to Follow (Section Chairmen should develop agendas for their meetings)

5. Section Meetings (run consecutively -- when one finishes, next will start)

   Biodegradable
   Photodegradable
   Chemical Degradable
   Environmental Fate
   Terminology

6. Reconvene Full Subcommittee

   - Reports from Section Meetings

7. Next Meeting Date and Location

8. Goals to be Accomplished by Next Meeting

9. Adjournment

WD/fcl
AGSUBD2096

Standards for Materials, Products, Systems & Services

MINUTES
ORGANIZATIONAL MEETING
SUBCOMMITTEE D20.96 ON
ENVIRONMENTALLY DEGRADABLE PLASTICS
CHARLOTTE, NC
MARCH 15, 1989

The Meeting convened at 1:05 P.M. EDST. Chair; R. Narayan and Wendy Dyer, ASTM Staff Member welc[omed] attendees and new visitors for their participation and attendance.

An introduction of attendees followed. The minutes of the previous planning meeting were then distributed to those present.

MS. Dyer then presented the following questions to the floor for consideration by those present:

1. Do we wish to form a permanent sub committee ?
2. Our purpose would be to set up the Standards and Scope.
3. We also should form task groups to handle the business of the committee in special areas as defined in the planning meeting.

MS. Dyer then presented the background of ASTM for new members and visitors. ASTM has approximately 34,000 members on 140 technical committees with about 5000 foreign members. The ASTM staff numbers about 225 primarily in Philadelphia. Small offices are also maintained in Washington, D.C. It was pointed out that one of the most important functions is the printing and mailing department . The staff coordinates the voting, membership and New Activity functions.

Mark Matlock then reported on terminology task force work to date.

R. Narayan reported on the work done on reviewing biodegradation and weight loss.

Marvin White recommended that four task groups be formed.

In answer to a floor comment, Ron Walling noted a chemical group might be formed.
Richard Wool commented that chemical and Macro-organisms both should be considered.

Mark Matlock noted previously that insects were living organisms and were previously suggested and reported in the literature

Also, Mark discussed the importance of chemicals such as polylactic acid and related compounds.

A floor question on, what is " chemically degradable " ?, brought the response from Ramani Narayan that some forms of it include: Oxidative processes, thermal processes and pH to name a few.

Tony Androtti noted we need further definition of the processes-- eg: whether it is biological, chemical, oxidative or whatever.

A proposal was made " To call Degradation a process brought about by a chemical action" For example, strictly speaking, biodegradation is hydrolysis from a chemical standpoint.

Robert Ennis commented that the process can be varied and some chemical forms can be considered very different.

Peter Chen noted that residue testing is needed to determine the "harmless" characteristics of the plastic in the final stages of deterioration.

Peter Klemchuk pointed out that the task groups need to clarify the terms and how to best determine type and amount of degradability.

Steve Harper asked for consideration of a "Fate" task group to d this very thing. From the floor it was suggested that " a layman's view " task group be considered.

Wendy Dyer then noted that we were starting to tackle task group functions and asked for a motion to form the committee be made. Charles Guttman.NTIS so moved. Mark Matlock seconded the motion and the vote was unanimous.

It was then moved to name the committee:
1. ENVIRONMENTALLY DEGRADABLE PLASTICS" by Ramani Narayan with a second by Charles Guttman. Discussion followed.

Other names then proposed included:

2. Degradable Plastics
3. Controlled Degradability of Plastics
4. Designed Degradability of Plastics

the vote then taken was 50 for #1, 28 for #2, 1 for #3 and 1 for #4. Number one, Environmentally Degradable Plastics was adopted. Next topic was the scope: After discussion the original scope from the first minutes in Toronto, Canada with the addition of environmentally degrade " passed nearly unanimously with only one nay.

A motion was made to elect Ramani Narayan, Purdue as chairman and Ron Walling, Advanced Materials Center as Secretary. The vote was unanimous.

Peter Klemchuk then moved to break out into task groups which was done. This was done at 3:15 PM.

The groups were:
1. Biodegradability
2. Photodegradability
3. Chemical Degradablity
4. Terminology
5. Fate Task Group

The groups reassembled at 4:30 PM and each group made a short report:

1. Richard Wool reported three sub groups formed. These were
- Larry Britton--Test Environments
Chris Graham---Measurements
Greg Olsen-----Standard Materials
Eleven tests were proposed for monitoring and will be considered.

2. Marvin White noted that the photo task force had met earlier and form four sub-groups:
1. Physical-Chemical Measurements
2. Fluorescent Ultra Violet Weathering
3. Xenon Weatherometer
4. Natural Sunlight - Accelerated weathering
The task forces would meet to submit documents prior to the next meeting.

3. Mark Matlock reported that new definitions for degradable plastic was discussed. A ballot is to be circulated in the group to poll acceptability to all.
Other terms were touched on but, not acted on.

4. Steve Harper reported the Fate task group covered the scope of the work.

5. The chemical group did not meet.

Group minutes were requested sent to Ron Walling for compilation and transmittal to Wendy for transmittal.

The next meeting will be the week of July 10-14, 1989 in Salt Lake City, Utah. Wendy will send out information on the exact date and time. It was proposed that D-10.33 meet concurrently since many of the members were present. Wendy will check this with Jamie after the D-10.33 meeting in Charlotte.

The meeting the adjourned at 4:50 PM

Respectfully submitted.
Ronald L. Walling

ASTM Standards for Materials, Products, Systems & Services

SUMMARY MINUTES
ORGANIZATIONAL MEETING OF SUBCOMMITTEE D20.96 ON
ENVIRONMENTALLY DEGRADABLE PLASTICS
CHARLOTTE, NC
MARCH 15, 1989

CALL TO ORDER

The meeting was called to order at 1:00 P.M. at the Marriott City Center in Charlotte, North Carolina. A list of attendees is included as Attachment A.

WELCOME AND INTRODUCTIONS

Wendy Dyer, Staff Manager of New Activity Development, welcomed those present and initiated self-introductions. Ms. Dyer stated that she will act as facilitator for this organizational meeting.

OBJECTIVES OF MEETING

The objectives of this organizational meeting were to:

1. Identify areas needing standards development.
2. Determine if a standards development activity on degradable plastics should be organized, and if so, in ASTM.
3. Develop a title, scope, structure, and elect officers.

BACKGROUND INFORMATION

A) The ASTM organizational process was reviewed. A planning meeting, bringing together approximately 60 representatives involved with degradable plastics, was held in October 1988. At this meeting the participants requested ASTM to move forward towards organizing a new standardization activity on degradable plastics.

B) The request for this activity came from Committee D-20 on Plastics. However, other individuals, companies and organizations also expressed a need for standards in the area of degradable plastics.

REPORTS FROM AD HOC TASK GROUPS

Three Ad Hoc Task Groups (Biodegradable, Photodegradable, and Terminology) were formed at the October 1988 planning meeting to begin initial standards development efforts. Reports from these groups were presented.

ACTION ITEMS

1. Future Direction of Activity

On a motion made and seconded, the attendees agreed on the need for standards for degradable plastics and requested ASTM to officially establish a new activity.

2. Development of Title

The attendees discussed several titles that may be appropriate for this activity. The following title was agreed upon by the majority of attendees:

"Environmentally Degradable Plastics"

3. Development of Scope

The attendees discussed various scope statements for this activity. The following scope was agreed upon by the majority of attendees:
"The promotion of knowledge and the development of standards for plastics which are intended to environmentally degrade"

4. Development of Structure

In order to best facilitate the development of standards for environmentally degradable plastics, the following structure was agreed on by the attendees:

Sections		Chairman
D20.96.01	Biodegradable	Richard Wool
D20.96.02	Photodegradable	Marvin White
D20.96.03	Chemical-Degradable	
D20.96.04	Environmental Fate	Stephen Harper
D20.96.05	Terminology	Mark Matlock

5. Election of Subcommittee Chairman and Secretary

The following individuals were unanimously elected:

Chairman: Ramani Narayan, Purdue University
Secretary: Ron Walling, Consultant

SECTION MEETINGS

The Sections on Biodegradable, Photodegradable, Environmental Fate, and Terminology met concurrently to identify how best to proceed with standards development work. Minutes from their meetings are attached.

CLOSING SESSIONS

The full group reconvened and reports were presented from each section meeting. If anyone has information related to a specific area, it should be forwarded to the appropriate section chairman. This material will be reviewed and provide the basis for the development of standards. If companies and organizations are presently using their own procedures, it would benefit both the company and this group to submit these procedures to Subcommittee D20.96. This will ensure that they are considered in developing full consensus standards, which can be used across the nation and internationally.

NEXT MEETING DATE AND LOCATION

The next meeting of Subcommittee D20.96 and its sections will be held in conjunction with the overall meetings of Committee D-20 on Plastics, as follows:

Wednesday, July 12, 1989 (8:00 A.M. - 5:00 P.M.)
Red Lion Inn, Salt Lake City, Utah

ADJOURNMENT

Wendy Dyer thanked the attendees for their participation. The meeting adjourned at approximately 5:00 P.M.

WD/fcl
MIND2096

BIODEGRADABLE PLASTICS

ASTM Section D20-5

Richard P. Wool, Sub-Section Chairman
Director, Degradable Plastics Laboratory
University of Illinois
1304 W. Green St.
Urbana, IL 61801

Phone (217) 333-2468
FAX (217) 333-2736

Marriott City Center
Charlotte, NC

March 15, 1989

BIODEGRADABLE PLASTICS MINUTES

INTRODUCTION

The general meeting on Degradable Plastics was divided into working sections involving 1) Biodegradable Plastics, 2) Photodegradable Plastics, 3) Chemically Degradable Plastics, and 4) Environmental Issues. This is a report on the activities of the Biodegradable Plastics section involving about 30 individuals.

MINUTES

A lively discussion developed on what constitutes a degradable plastic, its composition, its method of disposal via landfill, composting, litter, marine environments, and applications where degradability was considered an important feature of the material's performance. The role of microbes (fungi and bacteria) and macro-organisms (snails, slugs, crickets, etc.) in promoting biodegradation was discussed. The need to develop biodegradation standards for "black box" plastic materials (of unknown composition) became apparent.

Measurement techniques for biodegradability were proposed and discussed at length. Several techniques attempt to address the fundamental nature and mechanism of the biodegradation process while others measure the consequential effects of biodegradation. For example, mechanical property measurements are useful for characterizing the change in physical properties due to biodegradation but changes in mechanical properties alone are not sufficient to characterize biodegradability. Suggested measurement techniques include:

1) Mechanical Properties

2) Gas Evolution (CO_2, CH_4)

3) Spectroscopic Analyses of Chemical Changes

4) Weight Loss

5) Current ASTM Fungal Growth Techniques, e.g., G-21,G-22

6) Molecular Weight Change

7) Wet Chemical Separation Techniques

8) Metabolite Production

9) Accelerated Testing

10) Physical disappearance in presence of microbes and macro-organisms

11) Thermal Analysis

Working groups were formed to evaluate environments, measurement methods and standards. The Biodegradable Plastics section Working Groups and their Chairmen are as follows:

1) Measurement Techniques
Chairman: Dr. Graham Swift
Rohm & Haas Co.
Norristown and McKean Roads
Springhouse, PA 19477
(215) 641-7756

This group will analyze the measurement techniques to assess biodegradability and make written recommendations.

2) Test Environments
Chairman: Dr. Larry N. Britton
Director, Environmental Svcs.
Texas Research Institute
9063 Bee Caves Rd.
Austin, TX 78733
(512) 263-2101
(512) 263-3530 (FAX)

This group of 12 people will a) formulate issues (e.g., landfill vs. marine environment, aerobic vs. anaerobic; b) evaluate methods currently used (publications, methods, standards); c) suggested methods based on first hand experience.

3) Materials Standards
Chairman: Greg Olson
NIST, Polymer Division
Gaithersburg, MD 20899

This group will devise standard materials which can be used to evaluate biodegradation test methods and standards for various environments.

ACTION ITEMS

1) Working groups will prepare analyses by May 31, 1989.

2) Chairmen will communicate findings of working groups to R. P. Wool by June 1.

3) R. P. Wool will coordinate the working group reports and discuss summary draft with working group chairmen by June 12.

4) The summary report/recommendations on Biodegradable Plastics will be presented to the Section Chairman, Dr. Narayan, by June 20.

5) The report will be presented to the D-20 Section members at the ASTM meeting in Salt Lake City, July 10-13, 1989.

RPW:jl
03/28/89

astmd205

Standards for Materials, Products, Systems & Services

MINUTES
SECTION ON PHOTODEGRADABLE PLASTICS
MARCH 15, 1989
CHARLOTTE, NORTH CAROLINA

The Photodegradable Plastics Section has been organized into four working groups to provide information on specific standardization needs.

George Harlan, former Ad Hoc Task Group Chairman, had developed a proposed test protocol called the "strawman" test. This protocol served as the basis for discussion and from this discussion, it was decided to develop four working groups. These groups and their respective chairpersons are:

1. Fluorescent/UV - Patrick Brennan
2. Xenon Arc - Donna Graziano
3. Accelerated Natural Outdoor - Gene Zerlaut
4. Measurement Techniques - Marvin White

Each working group member is to submit to its chairman within one month, recommendations for the following topics:

1. Equipment description
2. Light source
3. Timing cycles
4. Comparison to natural sunlight
5. Temperatures
6. Specimen size and shape
7. Existing ASTM procedures; other supporting documentation

George Harlan will be unable to continue as chairman of this group. Marvin White was unanimously elected to replace Mr. Harlan.

Ethylene - Carbon Monoxide (E/CO) copolymer was selected as a reference standard. Samples of other commercially available photodegradable plastics such as plastigone, ampacet, and Ecolyte were requested. These materials will be evaluated "round robin" as plaques and films. The characteristics of individual resins after weathering (action spectra, CO content, etc.) will be studied. Appropriate physical testing methods for individual resins will be identified. Attention will be paid to those resins most often used as disposables; i.e., polyolefins and styrenics.

This Section on Photodegradables has scheduled a meeting on June 13, 1989 at ASTM Headquarters in Philadelphia. At that time, results from each working group within the section will be consolidated into one document.

Respectfully Submitted,

L. (Cindy) Ballinger

SIGN-UP FOR SUB TASK GROUPS

HOW TO MEASURE	FLUOR-UV	XENON ARC	OUTDOOR
Liz Stubley	Susan May	Mike Koyich	G Zerlaut*
M.A. White *	M. A. White	Donna Graziano*	Liz Stubley
Susan May	Ron Walling	M. A. White	M. A. White
H. F. Pillman	Patrick Brennan*	Tom Faulkner	Jim Dunlap
312-773-9300	H.F. Pillman	J. Gissendanner	J. Gissendanner
P. Klemchuck	J. Gissendanner		G. Hannemann
914-478-3131	Gerd Hannemann		
X4175			
Gene Zerlaut			
Richard Towne			
Linda Hill			
Julie Gissendanner			
Gerd Hannemann			
Lucinda Ballinger			

* Chairmen

SECTION ON ENVIRONMENTAL FATE OF DEGRADATION BY-PRODUCTS
MARRIOTT CITY CENTER, CHARLOTTE, NC
MARCH 15, 1989

CALL TO ORDER

The first meeting of the Section on Environmental Fate of Degradation By-Products (EF) convened at approximately 3:00 PM. A list of participants is included at the end of these minutes.

INTRODUCTIONS

Each person introduced themselves and stated their areas of training and expertise.

OBJECTIVES

The objectives of this meeting of the EF Section were to establish the goals of the Section, to decide on a Section title, and determine the future scope of the Section's efforts.

GENERAL DISCUSSION

The discussions in this Section focused on the need for defining the fate of degradation products, from a marketing standpoint and from an environmentalist viewpoint. From both perspectives, the definition of degradation by-products was concluded to be an important and essential task.

It was also concluded that we would need to be able to distinguish, in some disposal settings, the by-products originating from "degradable" plastics from those originating from "normal" plastics, which may also degrade (albeit much more slowly).

We discussed strategies for determining the nature and fate of plastics by-products, and it became apparent that this determination would require careful definition of the time element associated with degradation, and the nature of the disposal environment. It became obvious that the fate of by-products would therefore relate directly to the formal definition of "degradability". It was suggested that ultimately this definition may be dictated by the nature of the by-products formed.

Moreover, it was agreed that the definition of "degradability" would also be influenced by the nature of the disposal environment. Therefore, the fate of by-products will need to be addressed for at least several "model" environments, including, but not limited to:

1. Landfills,
2. Marine Environments,
3. Soil environments (buried), and
4. Soil and Sunlight Environments (not buried).

Also, it was noted that if "model" environments were to be used in standard test procedures, that these would have to be initially correlated to actual (real) environments.

Ultimately, it was concluded that the EF Section would need to interact closely with all three other Sections of this Committee. Interaction with the Terminology Section will aid in producing a definition of degradability which includes a by-products element to it, and eventually may include a toxicity (or lack thereof) element as well. Interaction with the Biodegradability and Photodegradability Section will help assure that the test methods derived by these sections will allow for timewise sampling to determine by-products (not only as they emerge, but also as they are subsequently transformed). Moreover, these tests must also allow a correlation between the test environment and actual disposal/receptor environments.

MISSION STATEMENT

The goal of this Section was unanimously agreed to be:

> To establish standard procedures for determining the by-products of degradation and their fate in the environment.

NEXT MEETING

July 10-13, 1989 Salt Lake City, Utah

PARTICIPANTS

Dr. Robert Ennis	Plastigone Technologies, Inc.	(305)274-1233
Dr. Peter Chang	Ethyl VisQueen Film Products	(812)466-0234
Mr. George Dula	Sealed Air Corporation	(704)758-5151
Mr. Robert Stickel	Aristech Chemical Corporation	(412)825-3467
Mr. Timothy Draeger	National Corn Growers Assoc.	(314)275-9915
Mr. James McCrea	Diversified Packaging	(301)974-4411
Dr. Walter Grube	U.S. EPA (Cincinnatti)	(513)569-7798
Mr. Tom Rogers	Government Services Admin.	(703)557-1930

(Several others joined in later, but were not listed on my roll)

MINUTES

TERMINOLOGY SECTION

March 15, 1989

—Summary of February 24 meeting

—Degradable plastic, biodegradable plastic, photodegradable plastic

—definitions read out
—commented on, voted by consensus

—D.K. Perseco: 1. Asked about wavelength of light?

—Summary of photodegradation meeting this A.M.
—Wavelenghts should be left up to test committee meeting.

2. Sunlight or light?

—came to same impasse as March 15, 1989.

—Dilemma over "disintegrates"

—M.M. ADM: mentioned alternatives: "loss of structural integrity".

—How to define "disintegration": comes from test methods again.

—D.G.: Union Carbide: proposed new definition of degradation.

—F. Borelli: Georgia Gulf: says degrade is a borrowed term and applying it to a plastic material—problem of what perception of degradation is.

—M.M.: What is fastest way to get results?

—E.S. Eco Plastics: Consensus from last meeting
—hard not to send it out for ballot.

—M.M.: Procedural format on what happens.

—F.B.: Other definitions to go on ballot.

—A.L.: US Army Ardec:

—If vote no on ballot, submit what you want for a definition.

—Commented that polymeric material would not be accepted for definition of degradable plastic.

—People felt that U.C. definition was quite good.

—Minor grammatical corrections were made to existing definitions.

—Vote on: including U.C. definition as part of ballots

—Put out as preliminary ballot for comments.

—D.B., Westlake Polymers: have to include two sets of definitions for each of three definitions.

—A. Landrock: can vote negative on one part only.

DEFINITIONS:

Degradable Plastics: Plastic materials that undergo bond scission in the backbone of a polymer through chemical, biological and/or physical forces in the environment at a rate which is reasonably accelerated, as compared to a control, and which lead to fragmentation or disintegration of the plastics.

—M.M.: Who plans on using definitions?

—D.K.: Has to be able to relate to customer.

Vote to put on ballot. Covered unanimously.

Biodegradable Plastic: [Those degradable pleastics where the primary mechanism of degradation is through the action] of microorganisms such as bacteria, fungi, algae, yeasts.

—M.M.: More appropriate to repeat degradable plastic.

—A.L.: Says common to use previous definitions. Left as is.

Photodegradable Plastic—of a light source.

M.A. Huff Cain Chemical: moved to put to vote; D.B. seconded—add to ballot unanimous.

—Subcommittee ballot - is going to Wendy Dyer.

—Other terms we need to define:

—Bioassimilation
—Intrinsic degradation
—Environmentally degradable - macroorganisms or deteriorate.

ATTENDEES:

John Nizio
David Bourgeois
David J. Kouchoukos
Jeanne McCaherty
Frank Burrelli
Arthur Landrock
Darrell Murphy
Tony Andrady
Andy Reistetter
Elizabeth Stubley
Daniel Foldberg
Mark E. Huff

ADDITIONAL QUESTIONS FROM CHAIRMAN GLENN

JAMES THOMAS

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1. S. 1237 would require the federal government to take advantage of private sector expertise and research through consultation and cooperation in developing uniform standards and testing procedures for degradable plastics. It is my preference that this process be complementary-- not exclusionary-- to the work currently being done by ASTM and others.

   Do you think this is a viable approach?

2. What do you see as the role of the federal government in the area of degradable plastic research and development?

Response to Question # 1

ASTM has a long and proud tradition of accomplishing its objectives in cooperation with the federal government. Government representatives sit on our committees and work with representatives of industry, academia and the consumer to set standardization priorities.

Strong elements of cooperation are necessary in a project of this magnitude. ASTM provides a unique system for development of highly credible technical documents. The best standards will result from bringing all interests to the table. Any effort by a single interest group will be viewed as questionable at best.

If your legislation moves forward, we certainly encourage you to utilize the mechanism that exists within ASTM to develop the necessary standards.

Response to Question # 2

The federal government can work within the private sector to accelerate the promulgation of standards which will be key to product advancement in the marketplace. ASTM has several examples where government seed money has been used to accelerate research and standards development. We would be glad to work with your staff on specifics, if requested.

TESTIMONY

OF

RAMANI NARAYAN

LABORATORY OF RENEWABLE RESOURCES ENGINEERING

PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA 47907

BEFORE

COMMITTEE ON GOVERMENTAL AFFAIRS
UNITED STATES SENATE

JOHN GLENN, CHAIRMAN

JULY 18, 1989

Ramani Narayan
Laboratory of Renewable Resources Engineering
Purdue University
W. Lafayette, IN 47907
Phone: (317) 494-6205 or (317) 494-7025
FAX: (317) 494-8323

INTRODUCTION

I appreciate very much your invitation to appear as a witness and testify on Bill S.1237, the **"Degradable Commodity Plastics Procurement and Standards Act of 1989."** The bill recognizes an opportunity to address critical issues facing the nation today:

(a) the growing environmental problems associated with the use of ever-growing disposable plastics

(b) the vitality and even the continued sustainability of our nation's agriculture system. As specified in the bill the development of new non-food uses like disposable plastics packaging for agricultural commodities will reduce crop surpluses, raise farm income, and lower the cost of agricultural subsidies provided by the Federal Government. However, another impact area of the bill that has not been brought out is the contribution of biodegradable plastics to sustainability of the agricultural system. The "composting" of degradable plastic waste, lawn, yard and other degradable wastes would provide much needed "carbon rich soil" for our depleted top soil. This will be discussed in greater detail later.

(c) the equally important energy issue which presently has been relegated to the back burner by the nation will be benefited by implementation of this bill. The use of our own agricultural resources in plastics as a substitute in part or even completely would reduce the use of foreign oil which is the base for all these plastics. While not going into too much detail on the energy issue, let me just point out that in 1987 alone the U.S. paid foreign countries nearly $40 billion for oil -- that's 23% of our record high trade deficit. Iran alone received over $700 million of that money.

In this presentation, I will discuss:

- Environmental concerns and potential solutions -- the solid waste management crisis and the need for environmentally degradable plastics.
- concept of biodegradable/degradable plastics and the misconceptions about it.
- concept of "composting" and the issue of landfills specifically relating to the much publicized findings of 20-30 year old degradable materials like paper in landfills.
- compatibility of degradable plastics technology with recycling and incineration
- fate and toxicity of the degradation products

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- current activities on the national and international level relating to degradable materials specifically relating to development of standards, test methods, terminology, classification etc.
- specific recommendations

ENVIRONMENTAL CONCERNS

1987 was a banner year for plastics production with a record 55 billion pound production and sales. Packaging accounted for 30% of the entire plastics market. It is this area of packaging in consumer goods which is the visible, disposable item that is being targeted for the degradable plastics market. The plastics production is expected to be close to 80 billion pounds by the year 2000 and a growing share of this plastics market would be in the disposable packaging and consumer goods.

This visible plastic litter (especially packaging items and disposable consumer goods like bottles, cups, wrappers, six-pack ring connectors, sacks, etc.) scars landscapes, fouls beaches and entangles sea creatures. Plastic accounts for 31.4% by volume in the municipal waste stream as opposed to the reported 7.3% by weight (this is assuming an average compacted density of 7 pounds per cubic foot). By the year 2000, this volume share will be 40% of the municipal waste stream. The current average landfill costs $65 per ton and is expected to double by the year 2000 and at the same time, 25% of major U.S. cities will be out of landfill capacity by the year 1991.

MARINE POLLUTION

Environmentalists estimate that the amount of plastics dumped into the ocean reaches more than one million tons worldwide per year. Woods Hole Oceanographic Institute reports as many as 45,000 pieces of plastic per square mile at sea. Ten miles of plastic netting from Asian commercial fishing operations alone are lost every day. The U.S. Navy disposes four tons of plastics including 450,000 plastic containers daily into the oceans. OTA reports that tens of thousands of sea birds and an estimated hundred thousand marine mammals die each year by ingestion or becoming entangled with plastic debris.

POTENTIAL SOLUTIONS

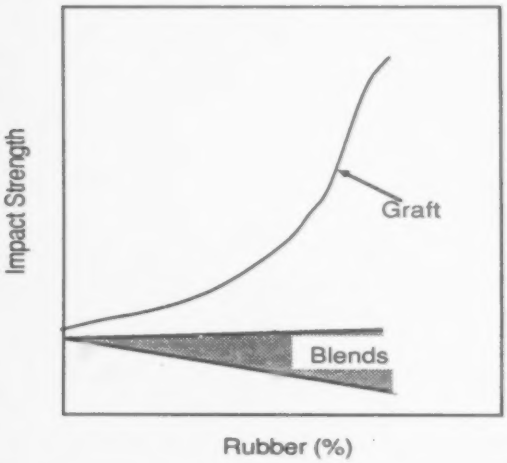
INCINERATION

This permits us to reduce the volume of the solid waste generated and converts waste to energy. However, there are a number of questions and concerns which have been

raised and need to be addressed. These are the problems of heavy metals, dioxins, acid gases, polynuclear aromatic hydrocarbons, ash disposal, etc. Last but not the least, incineration releases carbon dioxide with its potential problems of global warming -- an issue which has been in the news lately.

RECYCLING

Recycling has been touted to be **"THE"** method of choice for plastic waste management. Without a doubt, recycling is very important but it's only a part of the whole waste management issue. Only 25% of plastic waste will be suitable for reuse. This includes a handful of separable, reusable, recyclable packaging systems, for example, PET and PE bottles. Commingled waste, specifically single use packaging materials like wrappers are composed of a variety of generic polymer types not to mention the myriad of additives that go into it. These are difficult if not impossible to recycle. It has been claimed that commingled scrap waste in its entirety can be recycled to useful products. However, any polymer scientist recognizes that mixing of even two different types of polymer resins, for example polystyrene and polyethylene results in a product with very poor properties. Figure 1 illustrates this very nicely wherein the impact strength of a polystyrene-rubber mixture is very low and it is only with the addition of a "compatibilizer" that the blend properties dramatically improves. Furthermore the recycling of medically disposable plastic products is definitely out of question too.



ENVIRONMENTALLY DEGRADABLE PLASTICS

Thus, there is a definitive role for environmentally degradable plastics in this whole arena of waste management. Certainly, it is not the panacea for the entire waste management problem, but is one of the solutions which must be used along with recycling and incineration. Having made a case for the need for environmentally

degradable plastics, let us understand what we mean by degradable plastics and what we hope to accomplish with an environmentally degradable plastic. Biodegradable plastics does not imply that the entire material disappears completely into CO_2 and water. This is a myth and the biggest misconception about biodegradable plastics. Nothing, not even the well known degradable materials like dead plants and leaves are completely converted into CO_2 and water. A part of it is converted into humic material. Figure 2 illustrates these concepts and represents the carbon cycle of our

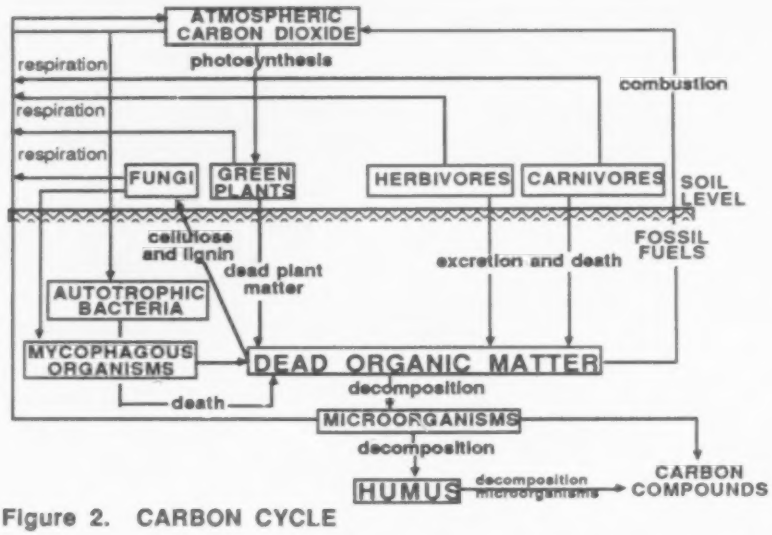


Figure 2. CARBON CYCLE

natural ecological system. Without going into too much detail, plants fix carbon dioxide by the process known as photosynthesis and grow. These then decay and produce dead organic matter as can be seen in the figure. The dead organic matter is acted upon by microorganisms which respire and produce CO_2, and convert the rest of the organic matter into humic material -- the carbon enriched soil material which is a friendly environment for survival of the soil micro and macro organisms as well as plants and crops.

RATIONALE FOR DEGRADABLE PLASTICS

Unfortunately, plastics are not inherently biodegradable and scientists, historically, have sought ways to make them more resistant to other kinds of degradation as well.

The resistance of plastics to biological degradation is due to a number of reasons. Microorganisms have not yet had time enough to adapt and synthesize polymer-specific enzymes capable of degrading and utilizing these man-made synthetic polymers of recent origin. The hydrophobic character of the plastics inhibits enzyme activity and the low surface area of the plastics with its inherent high molecular weights compounds the problem further. Furthermore, their strength and durability makes them impervious to accelerated breakdown in the oceans or on land.

Thus, the rationale is to modify these useful and convenient plastic materials so that they can be broken down under environmental conditions to "environmentally friendly material". Naturally occurring biopolymers like starch, cellulose, woody material are readily biodegradable. They degrade only in soil, sewage, and marine environments where bacteria are active; i.e. biologically active environments -- precisely the conditions where onset of degradation is desired. Incorporation of these types of biopolymers into the plastics materials by **blending** or **graft copolymerization** should lead to a new type of plastics having the trait of biodegradability. The natural polymers offers the water borne enzyme systems of the microorganisms a "foot hold" on the polymer surface -- a prerequisite for enzymatic action. Such a "starter" would trigger an enzyme induction mechanism, leading to the breakdown of the synthetic polymer chains as well. The natural polymer could serve as the nutrient carbon source for the microorganisms resulting in the release of non-specific oxidative enzymes which can attack the synthetic polymer chains leading to total biodegradation (natural polymer functions as a nutrient, luring the microorganisms into the plastic and serving as a good medium for their growth, thus promoting their attack on a polymer molecule otherwise unattractive to them). Furthermore, as the natural polymer is consumed, the plastic will be extensively eroded, pitted and embrittled leading to a porous polymer (readily permeable to oxygen and enzyme attachments) with increased susceptibility to microbial and oxidative degradation. **The end products of such a degradation would be humic material, CO_2 and water (in a aerobic environment).** It must be noted that Incorporation of photosensitive groups/additives into the plastics **(PHOTODEGRADABLE PLASTICS)**, which on exposure to sunlight (UV radiation) would cause radical induced polymer degradation. The resultant small molecules can be utilized by microorganisms and can be incorporated into the natural ecosystem (Figure 2). These systems, obviously, will not work in landfills or under water.

However as newer technology evolves, one is bound to see both photo and biodegradable triggers incorporated into plastic materials.

COMPOSTING

The time frames necessary for the natural ecosystems to operate will not be able to cope with the solid waste we produce, and this includes both the plastic and the naturally degradable lawn, yard waste, paper etc. In fact, it is estimated that one-third of municipal solid waste stream is lawn and yard waste. Currently, we pack our degradable lawn and yard waste into nondegradable plastic bags and bury them in landfills which have been designed to be tombs devoid of any moisture, oxygen. As a result there is no possibility of anything to degrade. We are in effect **"Preserving garbage for posterity"** and that is what today's landfill technology is. What we need is an accelerated degradation of the waste so that we can return the materials back to nature and close the materials cycle loop. This leads us to the concept of **composting** and **managed landfills** where accelerated degradation can occur.

Composting is defined as "accelerated degradation of heterogeneous organic matter by a mixed microbial population in a moist , warm, aerobic environment". This is practised in other countries as a viable waste management approach as shown below.

- **France has over 100 plants producing 800,000 tons of compost each year**
- **Sweden composts one fourth of its solid waste**
- **Europe leaning towards composting over incineration**

A conceptual composting scheme is shown in figure 3, wherein one can control and monitor the whole composting operation. As shown in figure 4, by composting our waste, we can generate carbon rich humic material which can address the issue of sustainability of our agricultural system.

COMPATIBILITY WITH RECYCLING CONCEPTS.

One of the major criticisms levelled at degradable plastics is that they are not compatible with recycling systems. While this may be true of photodegradable materials, the biopolymer based degradable plastics should pose no problem in recycling. A simple acid treatment of the waste material will hydrolyze the biopolymer

leaving behind the synthetic resins which are unaffected by the acid. In fact such a step will also get rid of any metal additives which may be present. This is shown in schematically in Figure 5. In fact, preliminary work done by us on the commercial starch based plastics showed that the starch can be readily removed by acid treatment.

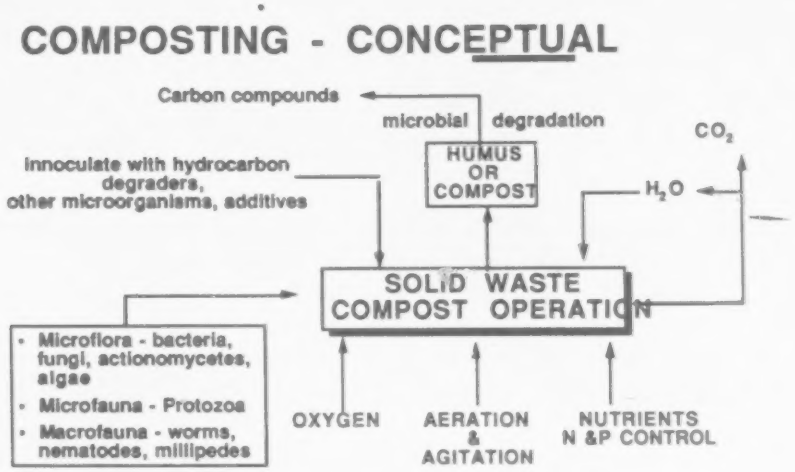


Figure 3. Conceptual Composting Operation

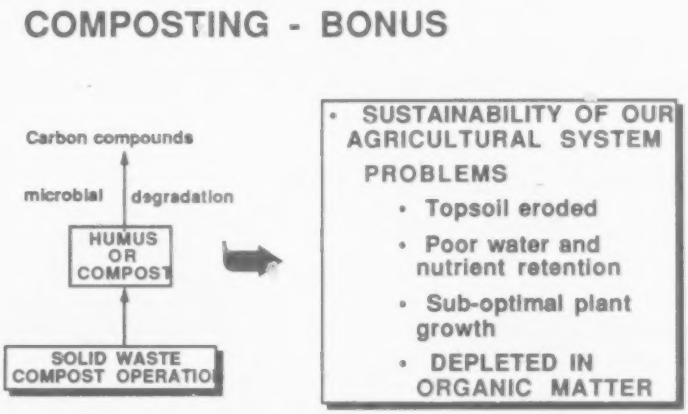


Figure 4. Composting supports agricultural system

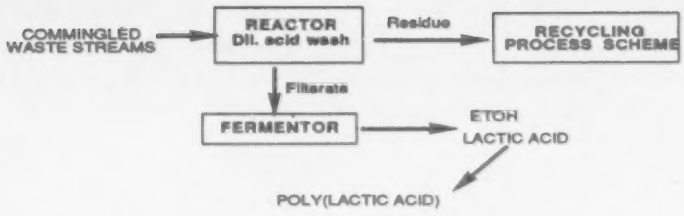


Figure 5. Compatibility with recycling concepts

CURRENT ACTIVITIES ON NATIONAL AND INTERNATIONAL LEVEL ON DEGRADABLE MATERIALS (Relating to development of standards, test methods, terminology and classification

An International conference aimed at reaching a consensus on degradable materials, specifically relating to terminology, test methods, degradation case studies, and fate of the degradation products is being organized in Toronto, Canada, November 2-4, 1989. The conference is being sponsored by Canadian and U.S. organizations and companies. I am one of the organizers of the conference and would be glad to send details of the conference to the committee.

ASTM has formally approved the formation of a Subcommittee D20.96 titled "ENVIRONMENTALLY DEGRADABLE PLASTICS" which I chair. The scope of the committee is " The promotion of knowledge and the development of standards (Classification, Guide, Practise, Specification, Terminology, Test method) for plastics which are intended to environmentally degrade " Much headway has been made and Figure 6 reflects the status and action items as decided upon at last week's ASTM meeting held at Salt lake city Utah.

RECOMMENDED ADDITION TO THE PROVISIONS OF THE BILL

In order to successfully implement bill S 1237 and to promote the continued development of environmentally degradable plastics technology, provisions must be made in the bill for a R&D effort in the area. I would like to urge the committee to provide $ 5 million for each of the five years to support the R&D efforts in this area. I have been fortunate to receive funding to work in the area of degradable plastics technology from 1. Department of Energy's Energy Conversion and Utilization Technologies Program (ECUT, Jim Eberhardt and Stan Wolf) through the Solar

Energy Research Institute (SERI, Helena Chum) and 2) National Science Foundation - -Biomass & Biochemical Division of the Engineering Directorate (Dr. Duane Bruley). I would like to place on record my appreciation to these federal agencies for recognizing the importance of this field long before others saw it. I believe that the additional funding will allow these organizations to implement a much wider scope of R&D efforts in this very important area.

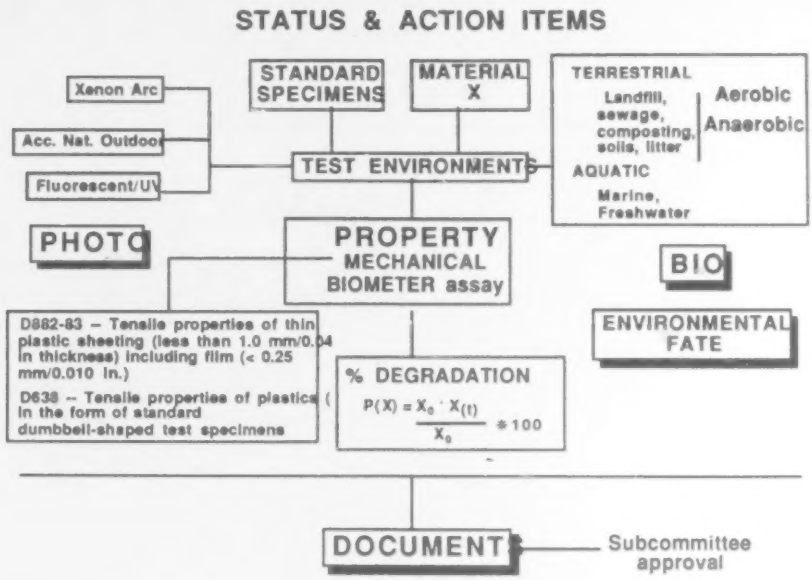


Figure 6.

ANSWERS TO ADDITIONAL QUESTIONS FROM CHAIRMAN GLENN

RAMANI NARAYAN
MICHIGAN BIOTECHNOLOGY INSTITUTE & CHAIRMAN, ASTM SUBCOMMITTEE ON ENVIRONMENTALLY DEGRADABLE PLASTICS

Q. 1. Do you think more research is needed.....?

Sufficient foundation of knowledge exists today that provides a basis for setting such standards. In fact, ASTM D20.96 (subcommittee on Environmentally Degradable Plastics) has put in a lot of work in this area. Documents concerning degradability definitions, test methods and test procedures have been prepared for balloting at the subcommittee level.

Q. 2. As one who is active in the research and..... ?

ASTM D20.96 has achieved considerable progress in the area and documents on definitions, test practises and test methods are currently being finalized for balloting at subcommittee level. I am optimistic that we will have major portion of the documents in place before the end of 1990. Of course, the work will not end there, classification schemes will have to be worked out, round-robin testing of samples at different laboratories will have to be carried out to validate the test practises and test methods developed. However, I believe that by end 1990, uniform definitions, test practises and test methods will be in place for Environmentally Degradable Plastics.

Q. 3. S 1237 would require the federal government to take?

As indicated earlier, ASTM will have developed standard definitions and testing methods, and it would be very appropriate for the federal government to utilize this body of knowledge and come up with specifications for degradable plastics in consultation and cooperation with ASTM. It would be a terrible waste of time, effort and money for the federal government to "reinvent the wheel" and go through another ASTM type deliberations to come up with definitions, test methods and uniform standards.

Q. 4. Do we have enough knowledge to date to make any ...?

RECYCLING vs DEGRADABLE PLASTICS

Recycling has received and continues to receive considerable attention as a solution to the growing plastic waste problem.

Without a doubt, recycling is very important but it's only a part of the whole waste management issue. Only a few percent the of plastic waste in the municipal solid waste stream will be suitable for reuse. This includes a handful of separable, reusable, recyclable packaging systems, for example, PET and PE bottles. Commingled waste, specifically single use packaging materials like wrappers, are composed of a variety of generic polymer types not to mention the myriad of additives that go into it. These are difficult if not impossible to recycle. It has been claimed that commingled scrap waste in its entirety can be recycled to useful products. However, any polymer scientist recognizes that mixing of even two different types of polymer resins, for example polystyrene and polyethylene results in a product with very poor properties. If, however the commingled scrap is used as a filler (the major component, still being virgin resin)to produce thick specimens like plastic lumber etc., then:

1. we are wasting precious virgin resin in producing materials of minimal value like picket fences, park benches etc. to prove a point that commingled scrap is being recycled. The virgin resin could have been better used to prepare useful materials instead of downgrading its value by contaminating it with waste scrap.

2. Postponing the inevitability of disposal -- recycle the material once then what do you do with the recycled material after use? for e.g paper cannot be recycled more than once, because it looses its structural integrity. Ultimately, one has to think of disposing the materials, and all that recycling does is postpones the question of disposability of these materials.

Furthermore, the recycling of

1. medically disposable plastic products like surgical gloves, masks, syringes,petri dishes etc.

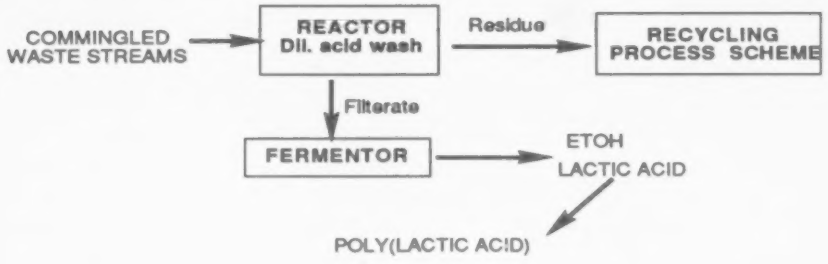
2. disposable diapers soiled with body fluids and composed of degradable wood pulp component, polypropylene backing, polyethylene strip, and adhesive tape

3. three-layered & five layered barrier packaging composed of different resin layers

is definitely not feasible.

COMPATIBILITY WITH RECYCLING

As illustrated in the following figure, a simple dilute acid pretreatment before recycling will ensure that all the biodegradable corn starch or cellulose are removed. In fact, the acid treatment step will remove all contaminating metal and other low molecualr weight additives which would complicate the processing of the recycled material. Thus, one can envision a scenario, where municipal solid waste comes to a receiving and separation station wherein materials that can be recycled are removed to enter the recycling stream and those that cannot as discussed earlier are degraded.

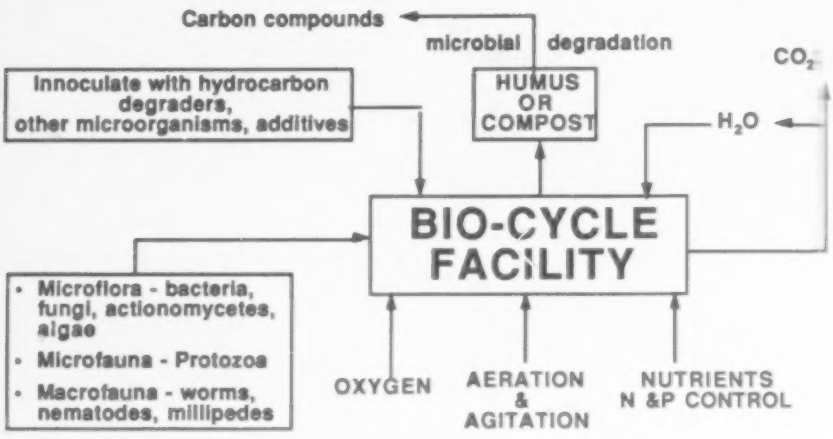


MUNICIPAL SOLID WASTE MANAGEMENT – LANDFILL TECHNOLOGY

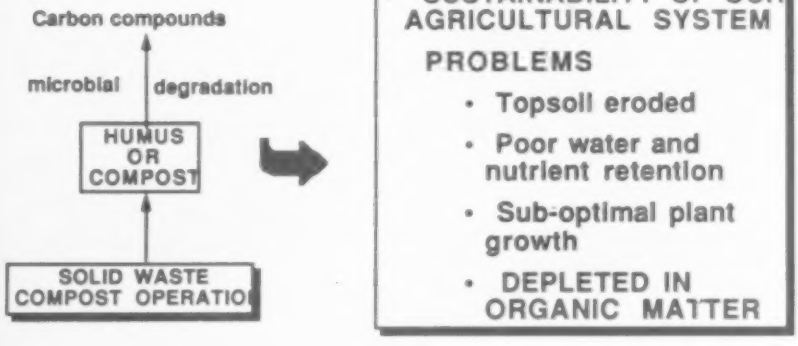
Today's landfills are huge plastic lined tombs devoid of oxygen and more importantly water and support very little microbial activity. As a result even degradable materials in the municipal solid waste stream like paper, lawn and yard waste degrade very very slowly if at all they degrade. We are in effect "preserving garbage for posterity" and that does not make any sense at all. The rationale for creating such tomb-like landfills is to apparently keep materials from leaching out or degrading. However, water and other type of ground movements will ensure that degradation will occur at such landfills, and will build up to explode some time down in future. In other words, these sites are "ticking time bombs" and will become the superfund sites of the future. What we need to do is to accelerate the degradation of the organic (biodegradable) waste so that we can return the materials back to nature. This leads us to the concept of **composting** and **managed landfills** where accelerated degradation can occur. In my testimony I have incorporated the

concept of a composting scheme and the benefits such a scheme would have on our agricultural system. These figures are reproduced below to substantiate these points again.

BIO-CYCLING (COMPOSTING) -- CONCEPTUAL



BIO-CYCLING - BONUS



Based on known biochemical mechanisms of degradation of such materials, the products of degradation are harmless and non-toxic. The biodegradation generally result in the formation of fatty acids and humic type materials. However, recognizing that there may be other additives in the materials that could be potentially toxic, one needs to ensure that the products of degradation are indeed safe. In view of this ASTM D20.96 will have test methods to look at the environmental fate of degradable plastics.

Q. Some have asserted that degradable products will have.....?

The answers to these points are elaborated in detail in the earlier discussions and the reader should refer to that discussion.

Q. From your familiarity with different types of ... ?

Basically, there are three types of degradable plastics, photo, bio and chemical. Photodegradable plastics serve a limited usage and is dependant on sunlight for its degradability. Thus, bio and chemically degradable plastics are more versatile and the concepts that incorporate both a bio and chemical trigger would be most promising. However, in all these plastics the major component is still a synthetic oil derived plastic. I believe that totally biodegradable plastics such as polyesters (for example polylactide derived from corn or other types of polyesters made from corn starch fermentation) or natural polymer based plastics like cellulose acetate and amylose acetate, where the synthetic polymer is just an additive, show most promise in terms of function and safety and represent the degradable plastics of the future.

Standards for Materials, Products, Systems & Services

July 7, 1989

FROM: Ramani Narayan, Chairman, D20.96

TO: D20.90 Subcommittee Members

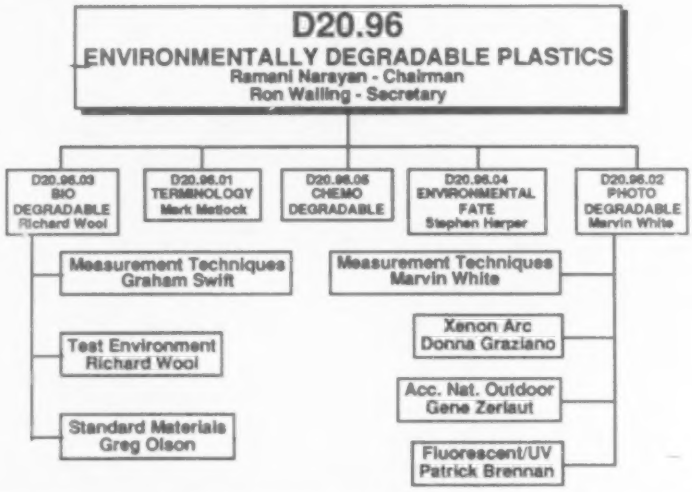
SUBJECT: Approval of D20.96 Sections and Scope

The title, scope and organization of D20.96 is appended below for your approval.

TITLE: ENVIRONMENTALLY DEGRADABLE PLASTICS

SCOPE: The promotion of knowledge and the development of standards (Classification, Guide, Practise, Specification, Terminology, Test method) for plastics which are intended to environmentally degrade

ORGANIZATION:



THIS WAS APPROVED BY THE EXECUTIVE COMMITTEE OF D20 ON PLASTICS AT THE JULY 10, 1989 MEETING IN SALT LAKE CITY, UTAH

ASTM 1916 Race Street, Philadelphia, PA 19103-1187 USA
Telephone: (215)299-5400 ■ TWX: 710-670-1037 ■ FAX: 215-977-9679

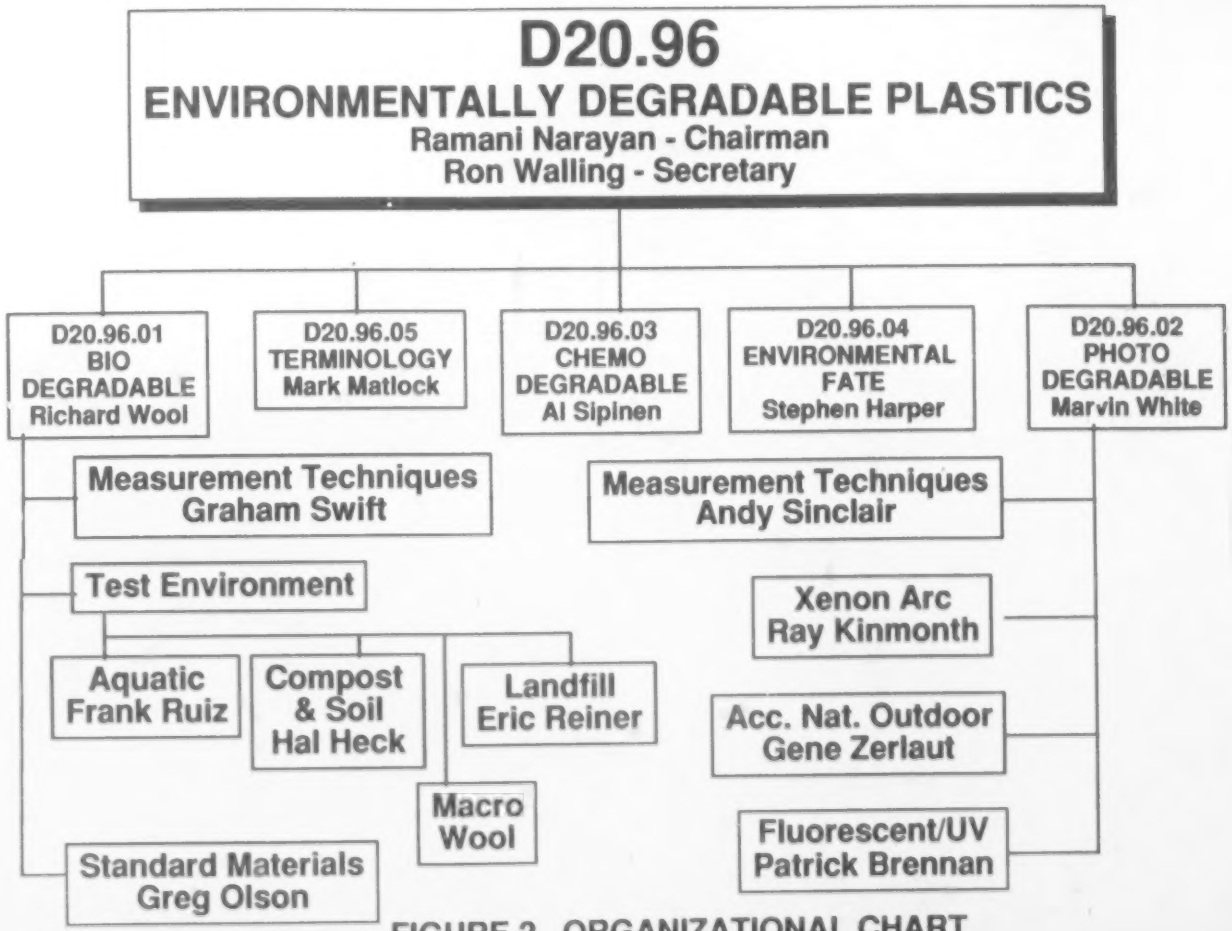
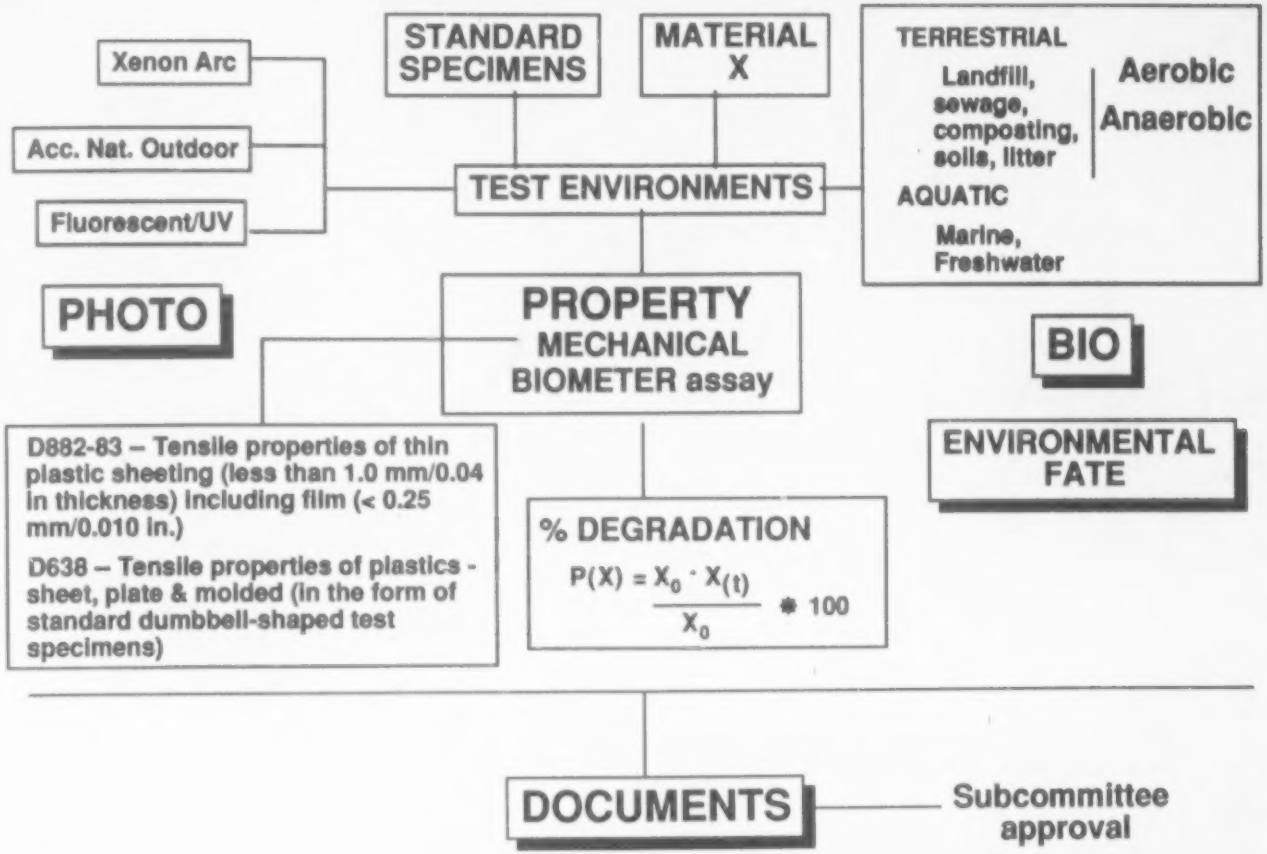


FIGURE 2. ORGANIZATIONAL CHART

STATUS & ACTION ITEMS



Comments of

Jerry L. Petak
Business Development Manager - Degradable Plastics

Archer Daniels Company (ADM)
P.O. Box 1470
Decatur, Illinois 62525

Appearing Before

Committee on Governmental Affairs
Hearing on S. 1237,
the "Degradable Commodity Plastics Procurement Act"

John Glenn, Chairman

July 18, 1989

Jerry L. Petak
Business Development Manager - Degradable Plastics
Archer Daniels Midland Company (ADM)
P.O. Box 1470
Decatur, Illinois 62525
Telephone: 217/424-5435
FAX: 217/424-2473

I appreciate the invitation of Senator Glenn to comment on S. 1237, the "Degradable Commodity Plastics Procurement Act". This paper presents responses to your questions, along with some of our thoughts and comments relating to the degradable plastics industry.

ADM is a manufacturer of agricultural foodstuffs of many types, processing corn, soybeans, wheat, rice, and many other agricultural products. We are a large supplier to the food industry, not only in the United States, but throughout the world, and are always working toward improving and expanding our markets for both food use and non-food use of agricultural products. This continuing effort to find new non-food uses for agricultural products is what led us to our current involvement in the degradable plastics industry. In mid-1987, we entered into negotiations with Dr. G. J. Griffin in England, to obtain the worldwide rights to a process of his own invention, that incorporates food-grade corn starch and polyethylenes, polystyrenes and polypropylenes which enables the producer to manufacture a degradable plastic product, using those base resins in the process. During the last two years, we at ADM have learned a great deal, both about the manufacturing techniques of degradable plastics, as well as the applications of product manufacture using degradable plastics as part of the raw material; and, of course, we have gathered significant data regarding the degradation of those products.

The first products for which we started producing a masterbatch were, of course, garbage bags and what are commonly referred to as carry bags or department store type bags. We have been successfully marketing a raw material masterbatch additive for that particular market for approximately 14 months. We are finalizing our formulation for a masterbatch that will service the high density polyethylene blow molding market. This product will be used in the manufacture of blow molded oil bottles, juice containers, detergent containers, milk containers, etc. During this same time, we have been simultaneously looking at the use of our degradable additives in polystyrene foams, rigid polystyrene products, such as aspirin bottles and picnic flatware, etc. In addition, we have been evaluating polypropylene material for injection molded applications of various types.

I have brought samples of these various types of products which we have produced. All of these products were produced in operating plants on full size production line equipment. The starch content of the products varies. The conventional film or bag material contains approximately 6% corn starch, which means masterbatch additive used contains 40% corn starch. We are continuing to test products which contain both more and less starch in these applications, depending upon the customer requirements. The high density polyethylene blow molded bottles range from 6% corn starch to 15% corn starch, with no loss of structural integrity to the bottles. The polystyrene foams we have produced (clamshells and containers) can range anywhere from 2% corn starch to 20% corn starch, depending upon the particular product application.

The cost of these various products will vary depending upon the customer's use and/or strength requirements. When we first started producing a masterbatch, our costs were about 30-40% higher than conventional plastics. During this last one and one-half years, we have become more knowledgeable in the manufacturing of the raw material masterbarch additive; and, as a result, as testified by our customers who are producing films and bags

of various types, our cost today will range, again depending upon application, anywhere from 5% to a maximum of 20% over conventional plastics. This same type of price range we feel will hold true with high density polyethylene blow molded bottles, injection molded items, and polystyrene foams should be less because of the manner in which the starch can be added to a polystyrene foam production line.

Since we have been supplying the marketplace with our degradable additive, the demand for these products has grown tremendously. Over the last year, our customer list has grown from virtually two accounts to approximately 30 plus accounts, using our degradable masterbatch additive, which is trade named POLYCLEAN™. The number of new accounts and customers who are using our POLYCLEAN™ product is continuing to grow, on a weekly basis. As far as the anticipated demands in the coming months, we, at this point, do not have a targeted number which we can pin on what the total demand for this product will be; as we are continuing to explore new applications for the product, as well as continuing to evaluate the various percentage levels of the additive which can be used in a number of products.

We have potential customers who are looking at product applications such as tampon applicators which will contain as much as 45% corn starch, as well as a polystyrene foam product which may contain as little as 2% corn starch or as much as 20%. We must be somewhat flexible in our thinking as far as what the product demand for degradable additives will be in the coming years.

Since we are a large supplier of food ingredients throughout the United States and the world, we are proceeding in a very conservative manner as far as food area applications are concerned. We have had a great concern since our initial involvement in this business with developing and maintaining proper standards and guidelines and, certainly, proper definitions for degradable plastics. When we entered the degradable plastics business, we made the decision to work through the ASTM subcommittee structure to establish proper definitions and terminology for degradable plastics, and we are continuing to work with ASTM system and are in hopes that we will soon be able to see some of the definitions and biodegradable methodology work completed so that each of us will have a good understanding of just what degradable plastics are and how they can be measured. We have, of course, had our own definitions for degradable plastics, biodegradable plastics and photodegradable plastics from our first involvement in the business and we are very happy to say that the ASTM proposed definitions for plastic degredation are similar to what we had initially thought would be reasonable. We are in hopes that those definitions which are currently proposed will be adopted. I have attached a copy of those proposed definitions for your information.

As could be expected, we have encountered a few situations in the marketplace which have caused us some difficulties because of not having these particular definitions outlined by a group such as the ASTM, and therefore, are very much interested in a timely finalization of the findings of ASTM so that a universal language regarding degradable plastics can be spoken in the marketplace.

The greatest problem which we have encountered relative to standardization has been that of degradation rates/starch content and/or degradable additive

content. It has been our experience that any film produced with a starch based degradable additive which does not contain at least 6% corn starch does not degrade as quickly as one would like for it to in many applications which are currently in the marketplace today.

Since our degradable additive, POLYCLEAN™, consists of not only food-grade corn starch, but three other proprietary ingredients which will react with or without sunlight and/or with or without moisture. Some standardization or a reasonable and demonstrable period of degradation time is essential for proper degradation definitions.

At this point in time in the marketplace, by far the best application for degradable plastics is the area of compost bags which will degrade in a matter of several weeks to a few months, depending upon the ingredients of the compost bag, and/or the composting environment. By utilizing degradable plastic bags in a composting program, great savings can be realized in the operation of compost projects through both labor savings and equipment savings, as a result of not having to open and handle bags.

I have taken the liberty of attaching some information pertaining to some composting programs that are currently being handled in the States of Illinois and Nebraska and some general leaf composting information which we find is very helpful to people in municipalities who are looking at the use of a composting operation to remove lawn and leaf waste from the general waste stream currently going into landfills, which, as you probably are aware, constitutes 17-20% of the solid waste in the United States. Through composting lawn and leaf waste in many municipalities and cities throughout the United States, we see a great savings of landfill space over a very short period of time. The technology is certainly available today to effectuate such programs.

The other applications for degradable plastics are emerging and look very favorable. Certainly, the consumer demand is increasing tremendously and as a whole, the degradable plastics industry is responding very well. Our costs are expected to decline with the increase in consumer demand and the ability of production plants to run longer periods of time on degradable products, thus reducing the per unit cost of operation, as in any new business.

Addition of degradable plastics additives is really no different than new basic conventional plastics product changes that have taken place over the last 10-15 years. We find it is a matter of the production facility learning how best to produce degradable products in the plants. Degradable plastic products can be produced without changing any equipment in most plant operations.

These comments, of course come from our customers, since we are not in the business of making plastic bags or any other plastic materials, but merely a raw material supplier of POLYCLEAN™, our degradable masterbatch additive.

Another issue which I would like to address is the recycling of degradable plastics. We have producers of degradable plastic films and/or bottles who recycle and regrind plastic scrap which is generated in the manufacturing plant itself. Examples of this would be recycling edge trim and ends

of rolls of plastic and/or flash or runners from injection molded processes. Degradable plastics of this type can be recycled without any problems, according to our customers. As far as post-consumer recycling in the area of plastic film, we have information on one experiment conducted with Reiffenhauser-Van Dorn Company, which is a firm that produces equipment used in the recycling of plastics. We used POLYCLEAN™ containing film which had was aged for 12 months. It was reprocessed by Reiffenhauser-Van Dorn into polyethylene pellets without any production problems whatsoever. The pellets then were used to make polyethylene film which had comparable properties to that of virgin degradable films. It must be remembered that our POLYCLEAN™ additive as we state in our process recommendation has a shelf life of approximately 14 months, and can be recycled without problems at least up to the age of 12 months. After that time, we do not have test data which would support a valid recycling effort at this point. Of course, a degradable plastic in our opinion would be one which would have served its purpose in 12-14 months, and that, as I mentioned earlier, is the type of market we are targeting for use of POLYCLEAN™.

As a result of the lack of uniform standards and definitions for degradable plastics, early on we discovered that we would have to supply many of the answers relative to degradation and how these products would act in certain environments, etc. We elected to enter into many private evaluations and test procedures which I will outline briefly and include the detailed report as an attachment to these comments.

The first of the studies is being conducted by the Waste Management Institute, State University of New York, Stony Brook, New York. The scope of the test study is to determine degradation rates in landfills, marine, tidal pool, and fresh water environments. In addition, there is a study being undertaken by the new products group, University of Missouri at Columbia, Missouri. The scope of this study is to develop test methodology for standard soil burial conditions, to determine the effect of polyethylene residues on soil drainage, fertility and erosion, and to study the degradation of starch containing polymers in compost environments. Also, plastic degradation is being studied in aroebic and anaroebic sewage systems at the University of Missouri.

Hazelton Laboratories, Madison, Wisconsin, is evaluating the use of products containing POLYCLEAN™ for FDA direct food contact extraction tests, as well as the Ames salmonella reverse mutation assay and the LD-50 abbreviated-limit test.

We have a short video which we normally use as an educational tool describing our degradable plastics additive, and I will include in this testimony a text of that film format.

JLP:mjp

ADDITIONAL QUESTIONS FROM CHAIRMAN GLENN

JERRY PETAK

ARCHER DANIELS MIDLAND COMPANY

1. How would the establishment of degradable definitions, standards, and testing methods affect the development, production, and marketing of degradable products?

2. What role should the federal government play in degradable plastic research and development?

3. What contact has ADM had with the FDA concerning the use and marketing of degradable food-packaging products, such as the fast-food container displayed at the hearing?

4. Some have asserted that degradable products will have a minimal effect on landfill capacity because a recent study claimed that newspapers, hot dogs, and conventional plastic bags-- some which were disposed of in landfills 20 years ago-- had remained intact. What stock do you place in this assertion, and what implications does it have for degradable plastics?

5. How will corn and other agricultural commodities be affected by increased production and use of degradable plastic products?

ADM
Degradable Plastics

ARCHER DANIELS MIDLAND COMPANY BOX 1470 DECATUR, ILLINOIS 62525 TEL: 217/424-5435

JERRY L. PETAK
BUSINESS DEVELOPMENT MANAGER
DEGRADABLE PLASTICS

September 22, 1989

The Honorable John Glenn
United States Senate
503 Hart Senate Building
2nd and Constitution NE
Washington, DC 20510

Dear Senator Glenn:

The following are answers to the additional questions you poseddin your letter of July 31, 1989. I have been traveling extensively, and I apologize for the delay in response.

1. The establishment of degradable definitions, standards, and testing methods would enable the degradable plastics market to proceed in a very straightforward and normal fashion. We definitely need the establishment of these criteria for both consumer protection and manufacturing protection, since this is a very necessary part of the total governmental and private sector acceptance of the product.

2. It is my opinion that the Federal government should play a very active role in the research and development of degradable plastics. As you know, these are, in our case, agriculturally related, and monies spent in research applications would be essential to agricultural states.

3. We have had several meetings with the FDA concerning the use of this particular technology and our proceeding forward. We find that the FDA has been most cooperative, and I will supply you details of our discussions under separate cover letter. We met with the FDA for the third time on September 14, 1989.

4. The findings of the particular landfill digs alluded to in the testimony as I mentioned, cannot be argued with. The point we make is that our degradable plastic formulation has never been in that situation, and we feel with the results of the tests that we have today, our product will, in fact, degrade in landfill conditions. I enclose a chart which outlines these findings and is based solely on conclusions in anaerobic and aerobic conditions.

5. Corn can be affected simply on a per bushel consumed level in the neighborhood of 50 to 100 million bushels. As this point, that level will be accommodated by simple excess capacity in the wet corn milling

industry, but should go hand-in-hand with increasing the price return to the farmer for those products. If we sell them as plastics, we will be enhancing the value as much as 40%, in the case of certain starches.

Thank you, again, for including me in your request for comment at the hearing on Senate Bill 1237, and if I can be of further assistance, please do not hesitate to call.

Sincerely,

Jerry L. Petak
Business Development Manager
Degradable Plastics

JLP:mjp

Enclosure

	Environmental Conditions	
	Oxygen	Little Oxygen
Water	Aerobic Carbon Dioxide Water	Anaerobic Methane
Little Water	Auto-Oxidative Paraffins or Humic Material	Slower Auto-Oxidative Paraffins or Humic Material

Primary Degradation Mechanism

Degradation End-Products

Michigan Biotechnology Institute
3900 Collins Road
P.O. Box 27609
Lansing, MI 48909
517/337-3181

TESTIMONY
DR. JACK H. PINCUS, VICE PRESIDENT FOR ECONOMIC DEVELOPMENT
MICHIGAN BIOTECHNOLOGY INSTITUTE
PRESENTED TO
THE COMMITTEE ON GOVERNMENTAL AFFAIRS
UNITED STATES SENATE
WASHINGTON, D.C.

JULY 18, 1989

Mr. Chairman and Members of the Subcommittee, thank you for this opportunity to appear before you today and submit testimony on biodegradable plastics technology. I would like to first commend you for your outstanding leadership on this issue, and for recognizing the potential ability of biodegradable plastics to revitalize our nation's agricultural sector and contribute to a solution to our waste management crisis.

I have been asked to comment on the proposed legislation, the Degradable Commodity Plastics Procurement Act, and to explain the work we are doing on plastics at the Michigan Biotechnology Institute (MBI). The proposed bill, with its emphasis on promoting the development of degradable plastics, is consistent with national agriculture and environmental policy goals as well as with the mission of MBI.

MBI is an independent, non-profit, commercially oriented biotechnology center. By concentrating solely on industrial biotechnology, our research and development efforts are aimed at transforming agricultural commodities, such as corn, into higher-value commercial products on a large scale. We are unique in that we conduct the applied research and scale-up activities necessary to take technology beyond the laboratory bench and transfer it to industry where it can be successfully commercialized. Our research programs are sensitive to market needs and fall into three general areas: fermentations and chemicals technology; industrial enzyme and bioelectronics technology; and waste treatment and biomaterials utilization technology.

At MBI, we are performing exactly the kind of research in plastics technology that S. 1237 seeks to generate and support. In our fermentation and biochemicals program, we are developing processes that use bacteria and other microorganisms to manufacture new end products from agricultural raw materials. These new products include components for second generation biodegradable plastics that can be used in manufacturing disposable plastic bags and industrial and food containers. Our economic projections estimate a total market value for biodegradable plastics of $90-600 million per year.

The two specific biodegradable plastics we are developing are polylactides and new polyol plastics. These will be the next generation of plastics that are totally biodegradable, as they will utilize carboxylic acids, or substances derived from them, as

feedstocks. Carboxylic acids provide a more biodegradable base for plastics products than do substances currently on the market which claim to be biodegradable. MBI's efforts are directed at reducing the cost of manufacturing the carboxylic acids so that they can be cost-competitive with petroleum-based chemicals. In addition, we are also investigating the use of renewable resources in the manufacture of carboxylic acids.

The provisions in the proposed legislation which promote the development of degradable plastics by offering incentives and increased access to government markets are excellent ways for the government to support this emerging technology. I would like to stress, however, the importance of supporting the technology development phase as well as the research phase. It is crucial that we integrate our research with real, commercial processes for manufacturing biodegradable plastics, and that we then successfully transfer these processes to industry. We must not lose the competitive edge in this field by failing to support the commercialization of the technology as aggressively as the basic research.

On another aspect of the bill, we applaud the attention you have given to the establishment of uniform standards and definitions for degradable plastics. Once again, this objective is in concert with MBI's programs and strategic business plan for the future. For instance, we are currently supplementing our project team with additional experts, expected to be on board at MBI in the fall of this year. This expanded team will conduct an objective review of existing definitions and test procedures for plastics that are termed biodegradable. As you have so accurately pointed out in the proposed bill, there are no

existing official definitions for what is a degradable item, and no standard, biological tests to evaluate product performance in controlled conditions. Obviously, these steps are necessary if we are to responsibly introduce degradable plastics into the marketplace and into the environment.

Efforts to develop test procedures and standards for degradable plastics will be a primary initiative for our waste treatment division. This program will compliment our on-going work in environmental biology for toxic and hazardous waste treatment; anaerobic treatment of industrial and manufacturing wastes; process monitoring and control; and pretreatment for municipal waste water sludge reduction.

At this time, I would like to briefly comment on the timeliness of S. 1237, or on the pressing need for legislation promoting the development of biodegradable plastics. I have just returned from Japan where I met with representatives from several chemical companies. During our discussions, the subject of biodegradable plastics emerged as a topic of great interest to the Japanese. Specifically, I learned that the Ministry of International Trade and Industry, or MITI, is preparing to launch a full-scale developmental program for biodegradable plastics to be centered at the Bioindustry Society of Japan. Moreover, MITI is directing this program to result in the practical application of a new type of biodegradable plastic in three to four years. Supplying an initial investment of $1 million, MITI is now positioning itself to become a major player in new plastics technology development.

Unfortunately, Japan's interest in biodegradable plastics does not come as a surprise to us. Indeed, Japan pinpointed biotechnology as one of three key technologies in its future a long time ago. Japan has subsequently acted on these plans by forming biotechnology consortia involving government, universities and businesses; obtaining access to U.S. biotechnology research by either buying into small U.S. firms or by purchasing licensing agreements; or by establishing research labs in the U.S. and employing U.S. scientists. Survey teams from Japan have visited research institutes in the U.S. and Western Europe, and biodegradable plastics is at the top of their list of inquiries. As I noted earlier, the Japanese are keenly interested in MBI's work with plastics, as they are in other industrial biotechnology processes with great commercial potential that we are developing.

Once again, I applaud your efforts to support the research, development and commercialization of biodegradable plastics, and I thank you for inviting me to testify today. I am hopeful that through a combined effort we can capitalize on our research in this area and be successful in transferring the benefits to the nation's agricultural sector and various industries. I would welcome any questions that you may have.

Bioplastic with variable hardness and shape

Associate Professor Y. Doi and his research group at the Research Laboratory of Resources Utilization, Tokyo Institute of Technology, have succeeded in synthesizing bioplastic by using an inexpensive material called 1;4 butanediol to produce a plastic of variable hardness, flexibility and shape.

Prof. Doi and his research group earlier succeeded in synthesizing a flexible bioplastic by using 4-hydroxybutyric acid, but this raw material is costly and is not practical for commercial production. In this respect, 1;4-butanediol is available at a low cost so mass producing the bioplastic with this new raw material is possible at a cost that is only a few times higher than that of petroleum-derived plastics. Commercial production of the material is therefore also possible.

Utilized in its synthesis is the phenomenon of polyester polymerization, generated in bacteria (Alcaligenes eutrophus), supplied with a special type of nutrient. The bioplastic, being a microbial derivative, is degradable by bacteria existing in soil or water, thereby eliminating the environmental pollution problem associated with existing petroleum-derived plastics. In addition, it is highly biocompatible and may become usable for producing various kinds of biological materials.

The UK's Imperial Chemical Industries commercialized a bioplastic about eight years ago, but the company's product is a co-polyester of 3-hydroxybutyrate (3HB) and 3-hydroxy valerate (3HV) and is very hard and brittle, making its moulding difficult.

Prof. Doi and his research group found the production of a new co-polyester of 3HB and a 4-hydroxybutyrate (4HB) by Alcaligenes eutrophus using 4-hydroxybutyric acid as the carbon source.

The 4HB component serves as the softening agent, so by regulating its ratio it will be possible to produce a wide variety of bioplastic plates: those which are hard or soft, pliable, transparent films, and threads and elastic rubber bands.

The problem is 4-hydroxybutyric acid's extremely high cost. Even with the most sophisticated synthesis techniques, the bioplastic material will be incapable of competing with inexpensive petroleum plastics if expensive raw materials have to be used.

To cope with this problem, the 4-hydroxybutyric acid was replaced with 1;4-butanediol as the nutrient source, and an attempt was made to synthesize a polyester co-polymer containing 4HB. As a result, the ratio of 4HB was varied up to 25 per cent and the substance was confirmed to be usable for obtaining very pliable films and threads.

The bioplastic material will be comparatively higher priced, but will become amply competitive with petroleum plastics depending on specific applications. (Source: JETRO, June 1988)

RESPONSES TO ADDITIONAL QUESTIONS FROM CHAIRMAN GLENN
TO JACK PINCUS, MICHIGAN BIOTECHNOLOGY INSTITUTE
SENATE COMMITTEE ON GOVERNMENTAL AFFAIRS
HEARING ON S.1237

THE DEGRADABLE COMMODITY PLASTICS PROCUREMENT AND STANDARDS ACT

1. How would the establishment of degradable definitions, standards, and testing methods affect the development, production, and marketing of degradable products?

Uniform definitions, standards, and testing procedures and materials are essential to the introduction of safe and effective degradable plastics into the environment. Without such standards, the public cannot be assured that it is purchasing plastics that are environmentally sound and that contribute to solving our nation's waste management crisis.

Specifically, we need to develop performance standards for degradable plastics regarding the rate and time frame of degradation; definitions and measurements of the degradation itself; standards for the composition and shape of test specimens; a uniform language regarding degradable plastics for the marketplace; and scientific tests of degradation within controlled environmental conditions. None of these means of defining what is meant by "degradable plastics" has yet been established and agreed to by the scientific community.

It is also important to stress that for standards and definitions to be developed that are broad enough that new technological breakthroughs are not discouraged.

2. What role should the federal government play in degradable plastic research and development?

The federal government must actively support basic research in degradable plastics as well as the commercialization of laboratory innovations in this field if we are to see these products developed in the U.S. and manufactured by U.S. companies. As we have seen in other advanced technology fields, the U.S. often leads the way in terms of research, and then loses the competitive advantage at the commercialization/manufacturing stage. Degradable plastics technology could be headed for a similar fate. The Japanese, for instance, have already expressed a great interest in degradable plastics, and are moving quickly to develop second-generation products, capitalizing on completed research and first-generation products. The federal government can play a significant role in getting degradable plastics to the marketplace by increasing federal funding for plastics research and development and funding for technology transfer centers that facilitate the successful commercialization of new plastics technologies.

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3. Some have asserted that degradable products will have a minimal effect on landfill capacity because a recent study claimed that newspapers, hot dogs, and conventional plastic bags-- some of which were disposed of in landfills 20 years ago-- had remained intact. What stock do you place in this assertion, and what implications does it have for degradable plastics?

Landfills are not optimum environments for biodegradation. They are devoid of moisture and oxygen and limited in microorganisms that can biodegrade certain materials. This problem transcends biodegradable plastics and concerns all organic materials disposed of in landfills. Therefore, the issue is not the implication of landfill conditions for biodegradable plastics, but how conditions in landfills can be changed to increase degradation.

Anaerobic microorganisms grow in the absence of oxygen and are capable of degrading organic matter. While present in soil, they are not available in adequate amounts for efficient degradation. Identifying anaerobic soil microorganisms responsible for degradation, enriching landfills with them, and providing a moist environment moisture will increase degradation of buried organic matter. Conditions for optimum degradation can be developed and tested in the laboratory before implementation.

An alternative to disposing in landfills is comporting. Organic matter is mixed with bacteria and air in a moist environment above ground under conditions that assure degradation of organic matter. The residual material has value as a fertilizer.

Whether landfills designed to improve degradation of organic matter or comporting is used for waste management, conventional plastics will not degrade and will continue to be a problem. Thus, the disposal problem created by plastics has a two-fold solution: use of biodegradable materials and disposal under conditions under which they will degrade.

4. How will corn and other agricultural commodities be affected by increased production and use of degradable plastic products?

According to the National Corn Growers Association, manufacturing the currently available biodegradable plastics currently available could increase demand for corn by 150 to 300 million bushels per year. Historical data shows that every 100 million bushels of corn used adds $0.06 to the price of a bushel. Adoption of biodegradable plastics could provide the farmer with an additional $0.09 to 0.18 income per bushel of corn produced and help reduce the need for agricultural subsidies.

WRITTEN COMMENTS
OF
RONALD LIESEMER
THE COUNCIL FOR SOLID WASTE SOLUTIONS

BEFORE THE
SENATE GOVERNMENT AFFAIRS COMMITTEE
July 18, 1989

In 1988, having recognized that products produced from plastics end up as municipal solid waste, the plastics industry formed and funded the Council for Solid Waste Solutions. This industry group, which is made up of the major plastic producers and users, has initiated programs to promote the development of technologies that will provide alternatives to landfilling plastics in ways that are environmentally sound, publicly acceptable and economically feasible.

The Council supports a hierarchical approach to solid waste management that includes:

1. Waste Reduction

2. Recycling

3. Waste-to-Energy Incineration

4. Landfilling

The Council commends the Committee's interest in developing new methods to reduce the nation's solid waste management problems. The Council agrees with the overall intent of S. 244 and S. 1237, but does not believe the means outlined in the legislation would result in an improvement in solid waste management.

Degradable plastics have been suggested as a possibility for reducing litter. However, the Council believes a degradability requirement would not reduce litter for the following reasons. First, the degradation process is too slow to cause litter to disappear; instead, to the extent degradation does occur, it will

1275 K Street, NW, Suite 400
Washington, D.C. 20005
202.371.5319
FAX: 202.371.5679

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cause numerous pieces rather than one large piece of plastic to linger in the environment. Second, littering is the result of human judgement and is a behavioral problem that can only be addressed through education. Furthermore, the knowledge that an item if littered will degrade, together with the mistaken assumption that the degradation process will cause the item to "disappear," will only increase the tendency to litter and will reinforce littering behavior.

The Council believes that degradable plastics may play a limited role in decreasing the threat to marine wildlife through entanglement with a few specific plastics products, and that degradable bags may be helpful to the process of composting yard waste. Beyond this limited benefit, however, requiring the use of degradable plastics would be counterproductive to achieving and maintaining an overall reduction in municipal solid waste. Degradable plastics, if mixed in the waste stream, can contaminate other plastics, compromising their value for recycling. The result is a net increase in the amount of plastics landfilled. Instead, landfilling should be used only as a last resort, for materials which cannot be recycling or recovered as energy.

Two approaches are currently being explored to make certain plastics more degradable in the environment. One approach is to significantly increase and accelerate the degradation that occurs when plastics are exposed to ultraviolet (UV) light. This process is known as photodegradation. Photodegradation does respond, at least partially, to the problems encountered when a product is littered. However, it is important to realize that photodegradation cannot occur when a product is buried in a landfill. Consumer perception that a degradable product will "go away" is incorrect for the reasons outlined below.

Biodegradation is another process which may be useful in reducing litter -- but will play an insignificant role at best in decreasing overall solid waste management problems. Degradation of any material in a landfill is a complex and slow process. Many materials generally regarded as degradable deteriorate either slowly or not at all in a landfill. EPA has estimated that over 60 percent of the materials currently being landfilled are considerable to be degradable. However, landfill conditions of dense pressure combined with an absence of oxygen, light, or water preserves even the most easily degradable items. Carrots, for example, have been recovered intact after many years in a landfill. Newspapers dating back to the 1960s have been retrieved from landfills, still identifiable. Additionally, the degradation which

does occur in landfills is discouraged by landfill managers. Degradation can cause leaching of toxic liquids, which not only can contaminate groundwater but also can make reclaimed land unstable.

The Council supports federal government initiatives which would result in improved solid waste management. Instead of federal procurement of degradable plastics, as advocated by S. 244 and S. 1237, the Council supports federal procurement of recycled plastic products. Additionally, the Council supports governmental studies which would result in improvements in solid waste management. However, the Council believes that studies called for in S. 244 and S. 1237 are overly narrow in scope, and should be broadened to address the question of whether degradability adversely affects the critical functional attributes of a product, its ability to be recycled, and whether degradability is environmentally sound.

The Council believes that S. 244 and S. 1237, if implemented, would not offer the long-term solutions needed to reduce solid waste. Instead, Congress should place greater emphasis on recycling -- and what cannot be recycled should be recovered as energy.

We recognize that industry must contribute to solid waste management solutions. This will require creativity and dedication, as well as cooperation with government, the environmental community, consumers, and industry. The missing element in the effort to recycle plastics has been an overall plan to address the obstacles blocking plastics recycling from becoming a way of life. Markets continue to be the weakest link in the plastics recycling chain. This has been described as the "chicken and egg" phenomenon. Many locales have deferred or rejected adding plastics to collection programs because they lacked or were unaware of, stable markets.

This is an area where federal policy leadership and incentives could be helpful. We must develop a national recycling framework sensitive to the business perspective because unless plastics recycling makes economic sense, it will not be implemented long-term. In evaluating the economics of recycling, the avoided waste management costs to industry, the public, and government should be included. The Council is committed to this effort. We look forward to working with Congress to establish and implement solutions to our solid waste management crisis.

FACING AMERICA'S TRASH:
WHAT NEXT FOR MUNICIPAL SOLID WASTE?

Interim Summary

June 1989

PRE-PUBLICATION RELEASE

Embargoed for release until June 18, 1989 (a.m.)

Congress of the United States Office of Technology Assessment
Oceans and Environment Program

Office of Technology Assessment

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FACING AMERICA'S TRASH: WHAT NEXT FOR MUNICIPAL SOLID WASTE?

Interim Summary

June 1989

The final assessment will be available late summer of 1989.

Congress of the United States Office of Technology Assessment
Oceans and Environment Program

Municipal Solid Waste Advisory Panel

Joseph Sax, *Chair*
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John Bazin
Anheuser-Busch Cos., Inc.

Gordon Boyd
Schillinger, Salerni, and Boyd

Paul Connett
Saint Lawrence University

Randall Curlee
Oak Ridge National Laboratory

Dana Duxbury
Dana Duxbury & Associates

Rodney Edwards
American Paper Institute

Jeffrey Hahn
Ogden Projects, Inc.

Michael Herz
Benjamin Cordozo School of Law

Walter Johnson
St. Paul Metropolitan Waste Control Commission

Richard Kattar
New England CRInc.

Raymond Naar
General Electric Plastics

Lorie Parker
Seattle Solid Waste Utility

Glenrose Pitt
Citizens' Environmental Advisory Committee
Louisiana Department of Environmental Quality

Neil Seldman
Institute for Local Self-Reliance

Barry Scher
Giant Food, Inc.

Peter Vardy
Waste Management, Inc.

Irvin White
New York State Energy Research and
Development Authority

OTA Project Staff—Municipal Solid Waste

John Andelin, *Assistant Director, OTA*
Science, Information, and Natural Resources Division

Robert W. Niblock, *Oceans and Environment Program Manager*

Howard Levenson, *Project Director*

Kathryn D. Wagner, *Assistant Project Director*

Judy Kowalski, *Analyst*

Joan Harn, *Analyst*

Administrative Staff

Kathleen A. Beil

Sally W. Van Aller

Workshop on State and Local MSW Programs, March 17-18, 1988

William Apgar
Pennsylvania Bureau of Waste Management

Jerome Balter
Public Interest Law Center

David Buckner
Illinois Department of Energy and Natural Resources

Fred Clinton
Michigan Department of Natural Resources

David Colbert
House Committee on Energy and Commerce

Hershel Cutler
Institute of Scrap Recycling Industries

Michael Downs
Oregon Department of Environmental Quality

Shelley Dresser
Council of State Governments

Dana Duxbury
Dana Duxbury & Associates

George Eowan
California Waste Management Board

Randall Franke
Marion County Board of Commissioners

Joseph Gilson
Camden County Office of Solid Waste Management

Janet Keller
Rhode Island Department of Environmental Management

Linda King
Citizen's Clearinghouse for Hazardous Wastes

Carolyn Konheim
Konheim & Ketcham, Inc.

Ruth Lampi
Environmental Task Force

Jerry Lederer
U.S. Conference of Mayors

Lynne Markus
Missouri Department of Natural Resources

Cassandra Maurer
Land-of-Sky Regional Council

Hector Mendieta
Texas Division of Solid Waste Management

Theodore O'Neill
Cape May County Municipal Utilities Authority

John Reindl
Wisconsin Department of Natural Resources

Ken Rosenbaum
Office of Congressman Ron Wyden

Neil Seldman
Institute for Local Self-Reliance

Jere Sellers
Franklin Associates

Mary Sheil
New Jersey Department of Environmental Protection

Don Silva
Science & Engineering Associates, Inc.

Gary Sondermeyer
New Jersey Department of Environmental Protection

Nancy VandenBerg
Markets for Recycled Products

Mary Wiard
Ohio Department of Natural Resources

Elliott Zimmermann
Illinois Department of Energy and Natural Resources

Workshop on Markets for Recycled Materials, June 8, 1988

Victor Bell
North East Recycling Association

Leroy Cooper
California Office of Procurement

Tom Couling
Great Lakes Recycling Coalition

John Gleason
New York State Office of Procurement

Jim Grove
Miami Paper Co.

David Jeans
American Iron and Steel Institute

John P. Josephs
Garden State Paper Co.

Steve Levetan
Institute of Scrap Recycling Industries

Stanton Moss
Stanton A. Moss, Inc.

Frank Reid
Anchor Glass Container

Paul Relis
Gildea Resource Center

Andy Stephens
Eaglebrook

Doug Stewart
Montana Recycling

Al Troglio
General Services Administration

Workshop on Incineration/Waste-to-Energy Issues, June 28, 1988

Donald Barnes
U.S. EPA Science Advisory Board

Marjorie Clarke
INFORM

Thomas Constable
Environment Canada

Richard Cook
Kalamazoo College

Richard Denison
Environmental Defense Fund

Keith Forester
Wheelabrator Environmental Systems

Michael Gough
Resources for the Future

Warren Gregory
Smith-Barney

Jeffrey Hahn
Ogden Projects, Inc.

Walter Schaub
CORRE

Jim Sears
Marion County Department of Solid Waste

Allan Smith
University of California

Workshop on MSW Reduction, July 14-15, 1988

Judd Alexander
James River Corp.

Mary Amini
General Foods Technical Center

John Burke
James River Corp.

Ron Catlett
Dow Consumer Products, Inc.

Dana Duxbury
Dana Duxbury & Associates

Rolf Faste
Stanford University

Harry Fatkin
Polaroid Corp.

Ed Fox
Proctor & Gamble Co.

Marc Goldberg
Safer, Inc.

Erica Guttman
Rhode Island Solid Waste Management Corp.

Roy C. Herndon
Florida State University

Ken Hunnibell
Rhode Island School of Design

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Pentapco Inc.

Ruth Lampi
Environmental Action Foundation

Wayne Martin
DuPont

Merilyn Reeves
League of Women Voters of the United States

Shelby Yastrow
McDonald's Corp.

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OVERVIEW

"Waste not, want not"—a notion that helped carve a Nation out of a wilderness, but increasingly a discarded concept. It is time to revisit this notion, reassess our attitudes about MSW, and plan a wise policy to guide the Nation into the next century.

Today we find ourselves facing growing mounds of trash and the label "throw-away society." Is it true? In the United States, we generate over 160 million tons of municipal solid waste (MSW) each year—more than one-half ton per person—and the amount is rising steadily (box A; figure 1 shows the estimated portions of materials and products in MSW, by weight). In 1986, only about 10 percent of all MSW was recycled and 10 percent was incinerated (mostly with energy recovery), while 80 percent—about 130 million tons—was disposed of in landfills (figure 2). Although landfilling has been the most available disposal method, the number of permitted landfills is declining and landfill costs are rising in many parts of the country. Recycling and incineration both can be increased, although they cannot totally eliminate our dependence on landfills.

Many areas of the country are experiencing shortfalls of permitted landfill capacity. The Environmental Protection Agency (EPA) estimates that 80 percent of existing permitted landfills will close within 20 years (figure 3).[1] Landfill capacity is declining primarily because of the concurrence of three interrelated trends: 1) older landfills are reaching the end of their expected lives; 2) environmental requirements are being strengthened by some States and local governments (which has resulted in the closure of substandard landfills, but which also can ensure that future landfills will be more environmentally sound); and 3) siting new landfills is difficult, in part due to public opposition.[2] This opposition results primarily from previous experiences with poorly performing facilities, concerns over potential health and environmental risks, "Not In My Backyard" (NIMBY) attitudes, and the failure of public officials to involve the public adequately at the beginning of the decisionmaking process.

In areas where landfill capacity is declining or exhausted, and where other management capacity such as recycling and incineration cannot be increased sufficiently in the short term, one of the options being pursued is to transport MSW to other jurisdictions within a State or to other States. Localities receiving these transported wastes express concern about additional risks to human health and the environment and the strain on their own MSW management capacity. Yet their legal leverage to restrict such shipments is limited.

The costs of MSW management are rising steeply, driven in part by these factors. Per person MSW costs are still relatively low, but the rate of increase already is causing financial problems for some communities. Further, as proper management of MSW becomes more expensive, the likelihood of illegal disposal will increase.

The regional and national implications of these problems are becoming evident, yet the Nation lacks a clearly articulated Federal policy for MSW. Consequently, State and local authorities receive little guidance to help them address their MSW problems. Although primary responsibility for MSW management rests with State and local governments, the Federal Government can help in two areas: first, by addressing some immediate problems and second, by addressing

[1]This estimate was made before EPA proposed its new landfill guidelines, which could further increase the number of closures. As the revised guidelines are now written, if existing landfills close within 2-1/2 years of their adoption, the landfill owner will be exempt from costly requirements for closing and cleaning up the facility. Substandard landfills are likely to close to avoid these costs.

[2]Siting is not only a problem for landfills, but also for other MSW management facilities, such as incinerators and recycling facilities.

the longer-term issue of how society uses and disposes of materials and products.[3]

The Federal Government could help address the most pressing problems by:

- resolving the uncertainty created by unfinished Federal guidelines on landfills and incinerators;
- addressing issues associated with increased interstate shipments of MSW; and
- providing better information about technical capabilities, comparative costs, and risks of different MSW management methods.

One immediate action that EPA could take to accomplish these goals, possibly with additional congressional guidance, would be to complete regulations for all MSW management methods. This would involve finishing the revision of the landfill regulations, adopting regulations for MSW incinerators, and developing regulations for composting and recycling facilities (some of which currently are unregulated at the Federal level). These actions would reduce uncertainties regarding requirements for new facilities and could help better protect human health and the environment. If increased Federal regulation of MSW management is to occur, it should be accompanied by strengthened Federal enforcement provisions. States would also need to increase enforcement action against improper disposal.

Congress could also address the issue of ensuring sufficient management capacity for MSW. For example, Congress could require each State to guarantee management capacity for a specified percentage of MSW generated within its borders—a "capacity assurance" provision.[4] Even with such congressional action, States and localities still may have problems siting the facilities needed to meet their capacity requirements. To address this problem, EPA could develop model siting and dispute resolution procedures. These procedures could suggest how a State authority, through binding arbitration or other methods, could resolve siting disputes that cannot otherwise be settled at the local level.

In addition to addressing these immediate problems, the broader issue of how the Nation uses materials—from manufacturing through subsequent distribution and disposal—should be considered. *A clear national policy on MSW that addresses the use of materials is essential for providing a broader context in which specific MSW programs can be developed and implemented. Waste prevention and materials management should be the foundation of this policy* (see figure 4).[5]

It is important to make a clear distinction between *prevention* and *management* activities to ensure that adequate attention is focused on each.[6] Prevention refers to activities by manufacturers (e.g., modifying products, including packaging) and consumers (e.g., modifying purchasing decisions) that reduce the toxicity or quantity of products *before* they are purchased.[7] The motivation for promoting MSW prevention

[3]Although it is beyond the scope of this report, it should be noted that the way in which we use our resources and materials has important implications not only for MSW, but also for other environmental issues such as global warming, natural resource conservation, and pollution abatement.

[4]A capacity assurance provision, for example, is included in both the Comprehensive Environmental Response, Compensation, and Liability Act and the Low-Level Radioactive Waste Policy Amendments Act. Implementing such a provision for MSW, however, would differ.

[5]The materials management approach builds on materials use concepts that have been discussed for many years (e.g., Ayers and Kneese, 1969; Kneese and Bower, 1979; OTA, 1979). In fact, many communities practiced a form of materials management prior to the 1960s, when they routinely separated discarded materials for management. Only in recent decades have most communities collected mixed MSW, a trend that was encouraged by, for example, the advent of collection trucks that compact MSW.

[6]This differs from the concept of "integrated waste management" espoused by EPA and others, because that concept includes prevention within a hierarchy of management options.

[7]Product modification also has implications for the management of products discarded as MSW (e.g., the recyclability of a product). It should also be noted that OTA includes backyard composting of yard and food wastes as a form of quantity reduction because no public or private sector management is involved.

is strong and simple. Reducing toxicity would make all management methods safer and could restore public confidence in waste management policies and programs. For example, reducing the amounts and types of organic chemicals in landfills would mean less air pollution (e.g., from volatile organic chemicals) and less toxic leachate. Quantity reduction would mean that, at some point, the overall capacity for managing MSW would not have to increase, which in turn could lead to a decline or stabilization in the costs of MSW management.

OTA cannot predict the extent to which waste prevention will occur, but this approach offers important potential benefits that are worth pursuing. If Congress includes prevention as part of its national policy for MSW, there is widespread consensus that a vigorous Federal role will be needed to pursue these opportunities. This is in part because the Federal Government has the potential to affect products and materials that move across State boundaries. In addition, one important consequence of a national MSW prevention policy would be that the government would become responsible for leadership in putting the policy into practice. To date, MSW prevention has received little congressional attention and EPA has not had the resources or political motivation to promote it.[8]

Even assuming notable progress in waste prevention, communities will continue to generate large amounts of MSW requiring management. In addition, unless prevention efforts successfully reduce the toxicity of all products, toxic constituents will remain in MSW, either because some products are toxic *per se* (e.g., pesticides) or contain substances that can be harmless in the product but pose toxicity problems during waste management (e.g., cadmium in some plastics). For these reasons, a comprehensive MSW strategy must consider both prevention and management.

OTA suggests that "materials management" has two aspects. First, MSW management should be approached on a material by material basis, in which discarded materials (including discarded products, yard waste, etc.) are diverted to the most appropriate management method based on their physical and chemical characteristics. Second, the manufacturing of products should be coordinated with the needs of different management methods (e.g., by designing products for recyclability) (see figure 4).

To establish a framework for deciding how to manage MSW when it is generated, OTA considers materials and energy conservation (already stated as objectives in the Resource Conservation and Recovery Act, or RCRA) to be national goals, and assumes that each management method is designed to ensure the safety of human health and the environment. The framework developed by OTA suggests that local decisionmakers consider recycling (and composting) first, followed by incineration and landfilling, recognizing that all of these management methods may be needed.[9]

Recycling is given the top priority based on: 1) its materials conservation benefits compared with incineration and landfilling and 2) its energy savings, at least for some materials such as aluminum, compared with manufacturing using virgin materials. Further, assuming that adequate regulations exist for both primary and

[8]There are signs of change at EPA, however—for example, a proposed policy statement on pollution prevention (54 *Federal Register* 3845, Jan. 26, 1989). Various pollution control agencies also have endorsed this concept (e.g., WPCF 1989). How applicable these policy statements will be to MSW, as opposed to hazardous waste, remains to be seen. However, a recent EPA report devoted to MSW stressed the idea of MSW prevention (EPA, Feb. 1989).

[9]Although the term "hierarchy" is often applied to MSW, OTA does not use the term because it suggests a rigid, linear approach to decisionmaking.

secondary manufacturing facilities, recycling may produce fewer pollutants overall.[10] Incineration of combustible wastes is given preference over landfilling because it destroys pathogens and organic materials, decreases the volume of waste destined for landfills, and often can be used to recover energy economically.

At the local level, communities would use this framework to decide how to manage particular materials *in light of local conditions*. This entails considering factors such as: human health and environmental risks, management costs (including capital, operating, and collection/transportation costs), availability of technologies, market conditions for secondary materials, and public acceptance of various alternatives. Although many communities have explicitly or implicitly adopted a MSW "hierarchy," they generally have not considered all of these factors. A national policy of materials management would encourage more complete consideration of these factors. A materials management strategy should also be flexible, so that MSW management methods can be chosen on the basis of regional and local variations and limitations, and changes in these conditions over time.

Implementing a materials management approach at the local level will require MSW to be thought about in terms of its components instead of as an indistinguishable mixture. This means that residences and commercial establishments will have to keep some waste materials separate to make subsequent management safer and more economical.[11] For example, separating yard waste for backyard or municipal composting can reduce, to some extent, leachate from landfills and nitrogen oxide emissions from incinerators. Separating recyclable materials before they are mixed with other waste improves their quality, thus making them more valuable and easier to market.

Implementing a national policy that emphasizes MSW prevention and materials management would require strong Federal leadership. Congress has the opportunity to provide the basis for such leadership during the reauthorization of RCRA, the primary Federal authority regarding MSW (box B).

The remainder of this summary presents specific policy options for Congress to consider. Each policy option is discussed in the context of the technical material that will be presented in OTA's final report.

POLICY OPTIONS

Introduction

Decisions about how to manage MSW today and tomorrow are becoming increasingly difficult, particularly for the local governments that have primary responsibility for MSW management. The Federal Government respects State and local primacy in MSW issues and to date has assumed a limited role in MSW management. EPA has primarily focused on developing guidelines for Subtitle D landfills and for procurement of products containing recycled materials. During the late 1970s, EPA also encouraged the development and implementation of Solid Waste Management Plans by States (box B). In general, Federal attention to MSW lapsed during the 1980s, primarily because the Nation focused instead on hazardous waste. Some States and communities, even without Federal involvement, have developed noteworthy programs promoting recycling and requiring that new incinerators and landfills use the best technologies available.

[10]Primary manufacturing refers to production with virgin materials; secondary manufacturing uses materials recovered from waste. If recycled products replace products made from virgin materials, potential pollution savings may result from the avoidance of manufacturing and subsequent disposal of replacement products made from virgin materials.

[11]Separation can occur, for example, at dropoff centers, through curbside collection, or in centralized facilities. The choice is not always clear, even on a technical basis.

EPA's recent "Agenda for Action" (EPA 1989), which outlines goals for the Nation and future MSW activities at EPA, signifies increased attention to MSW at the Federal level (box C). The success of EPA's efforts, as well as other activities within the public and private sectors, will in part depend on how Congress addresses MSW issues in the upcoming reauthorization of RCRA.

At least two important MSW concerns are driving the Federal Government to re-examine its role with respect to MSW issues. The first is the decline in existing landfill capacity, along with the inability of many local governments to site new MSW facilities of any type. Second, several issues have arisen with consequences that extend far beyond any one community, and these seem most feasible for the Federal Government to address. One such issue, for example, is the need to encourage manufacturers to consider the MSW management implications of their products (e.g., volume, toxicity, or recyclability) as they are designed.

The policy options discussed here focus on possible congressional actions. Options that can be undertaken independently by or in coordination with other entities (e.g., State and local governments, Federal agencies, and the private sector) also are noted. Specific actions regarding MSW are likely to be more effective if they are delineated in the context of a coherent, comprehensive approach for the Nation, and this can only be done if a national policy for MSW is established. *Congress can provide strong leadership by stating a clear national policy for MSW*, one that contains clearly articulated goals and sets priorities for action. Such a national policy could set the stage for moving toward a balanced, long-term approach to MSW problems. Appropriate goals might be:

- set MSW prevention as a national priority (i.e., reducing MSW toxicity and quantity);
- set the development of sufficient MSW management capacity throughout the Nation as a national priority;
- promote the use of management methods that provide materials and energy recovery benefits; and
- regulate MSW management methods so that each ensures adequate protection of human health and the environment, and vigorously enforce these regulations.

Policy options are discussed here in two major sections. The first section discusses options related to the Federal role in enhancing the institutional framework for MSW (e.g., ensuring capacity, aiding planning and coordination). These options address issues associated with **both** prevention and management. The second section consists of four parts analyzing options for programs and activities specific to prevention, recycling, incineration, and landfilling. Many of the options are related in that they all are oriented toward implementing the goals stated above and an institutional framework for MSW. Table 1 lists these options.

Enhancing the Institutional Framework

The system that generates and manages MSW includes a range of participants that manufacture, distribute, consume, and dispose of materials and products. Key components of this system are listed in box D to highlight where specific options might be applied most effectively. The institutional framework includes the governmental entities that affect the interactions between these participants. Five categories of options to enhance the institutional framework are discussed: improving integration (planning and coordination), ensuring capacity, promoting enforcement, improving information flow, and devising funding mechanisms for Federal activities.

Integration: Planning and Coordination

A coherent strategy will be required to avoid the piecemeal approach of past MSW policies. Cooperative efforts already are increasing, espe-

cially between States and local governments and between these levels of government and the private sector. In many cases, however, there is a critical lack of teamwork between affected groups, particularly with respect to waste prevention and recycling. As the Federal Government further defines its role in MSW issues, the limits of its authority need to be delineated and the implications of this authority for actions by State and local governments need to be considered carefully.

Option 1: Require State MSW Management Plans

Careful planning is crucial to the development of effective MSW programs, especially given the time and resources required for implementation. It is an open question what the Federal role should be in MSW planning. The Federal program for State Solid Waste Plans (RCRA Section 4002) essentially has been inoperative since 1980. Some States have continued to develop their own plans, but the content and utility of these plans varies. Because all State plans are not comprehensive in their approach to MSW, *Congress could require States to submit plans to EPA and specify particular issues that must be addressed.*

State plans, for example, could be required to provide: 1) programs to encourage prevention and administer materials management; 2) coordination mechanisms among State and local agencies and the private sector; 3) specific information on the amounts and composition of MSW generated; and 4) assessments of how adequate management capacity will be made available for MSW generated in the State. In addition, Congress could provide specified Federal funds to States with approved plans and/or withhold funds from those whose plans were not submitted or could not be approved.

Although States currently are not required to submit Solid Waste Plans, RCRA does list a number of requirements which must be met if submitted plans are to be approved (RCRA Section 4003). For example, one requirement is that the plan evaluate the size of waste-to-energy facilities (i.e., incinerators that generate electricity) in relation "to the present and reasonably anticipated future needs of the recycling and resource recovery interest within the area encompassed by the planning process" (RCRA, Section 4003(d)). Some of the RCRA requirements need modification, however. Some specified requirements may no longer be relevant and new issues may warrant inclusion. For example, because recycling cannot provide a consistent level of management due to fluctuations in market prices, it might be useful if plans were required to address procedures for how MSW will be managed during periods when market prices for secondary materials drop below a certain level.

Option 2: Interagency Coordination

To ensure that a more coherent and coordinated Federal effort is developed, *Congress could require that EPA and other Federal agencies establish an action-oriented interagency task force to review and coordinate Federal activities and policies that affect MSW generation and management.* A task force also could develop methods to compare the effectiveness of different programs. The primary difficulty facing such a task force, however, would be ensuring that its recommendations are implemented or at least considered seriously. Congress could require that the recommendations be reviewed and plans for implementing them be made by EPA and other agencies, unless there are demonstrable reasons for not doing so.

Ensuring Capacity: Siting, Interstate Transportation

Citizen opposition to the siting of new facilities remains widespread in many areas, even when the facilities would meet strict standards, but some new incinerators, landfills, and recycling facilities are being built. Siting a new facility can take 7 years or more, and an additional 2 to 3 years to obtain a permit and

construct the facility.[12] Various studies indicate that if the public is involved *early* and *substantively* in the process of selecting, evaluating, and locating facilities, the chances of successful siting are improved significantly.

Interim solutions will be needed to meet immediate capacity needs in areas that will exhaust their current permitted capacity within a few years and that have been unable to site new facilities. The most common interim solutions are increased transportation of MSW to other jurisdictions and expansion of existing landfills. Shipping the waste elsewhere often is the only option. Many communities with available capacity, however, are increasingly unwilling to accept MSW from other jurisdictions. Some States have enacted bans or restrictions on waste from out-of-State (or localities have enacted such restrictions against other localities within a given State). Some of these restrictions have been invalidated when the courts have determined that the bans unduly constrain interstate commerce.[13]

Option 1: Barriers to or Compacts Against Interstate Transportation

One alternative for addressing jurisdictional problems is to provide a mechanism for cooperation in interstate MSW transportation. For example, interstate compacts have been used to deal with issues such as low-level radioactive waste disposal, navigation and flood control, water pollution control, community development, and crime prevention (Kovacs 1988). In fact, provisions exist in RCRA (Sections 4002(a) and 4006(c)) that encourage interstate regional planning to facilitate MSW management. These provisions have not been implemented, but could provide a basis for allowing States to enter into agreements on MSW issues such as transportation of wastes, disposal fees, or development of new management facilities. Instead of erecting a barrier, this would allow wastes to move unimpeded across State lines, but in an orderly manner.

Assuming compliance with the Commerce Clause, which allows the Federal Government to regulate interstate commerce, *Congress could allow States to impose fees or other legal barriers on MSW imports.* Or, Congress itself could impose fees on MSW transported across State borders or adopt other mechanisms to discourage interstate shipments. These choices have important implications. Not least, they would represent a major change in the Federal approach to both interstate transportation and MSW management. In addition, although some States may want authority to restrict MSW shipments to their jurisdictions, other States (particularly those with adequate available capacity) may oppose attempts to restrict interstate transportation of MSW.

Option 2: Require States to Ensure Adequate Management Capacity

As part of the State solid waste planning provision in RCRA, *Congress also could require "capacity assurance" for MSW—that is, require States to ensure that adequate management capacity is available within specified time periods.*[14] "Adequate" could be defined as the ability to manage a specified percentage of the MSW generated within a State's borders. One mechanism to encourage the development of new capacity would be to require that permits to expand existing landfills only be in effect for a limited time and include an enforceable timetable for providing new capacity. Federal funding (e.g., Superfund money or highway funds) to States could be contingent on meeting this and other State planning requirements.

[12]In the future, with new siting procedures, the time required to site facilities may be reduced.

[13]See Kovacs and Anderson (1988) for discussion of the relevant court decisions.

[14]See footnote 4.

Option 3: Develop Model Siting Procedures

Another option is to establish better procedures for siting facilities. *Congress could direct EPA to develop guidelines for State siting procedures.* Such procedures could, for example, require binding arbitration by a State authority when siting conditions cannot otherwise be negotiated successfully. Similarly, the Federal or State Governments could provide resource or mediation teams to help local communities resolve siting disputes. To enforce these requirements, Congress could withhold Federal funds from States that did not meet the capacity requirement, or it could provide supplemental funds to States that meet siting goals or adopt a siting process.

Enforcement

RCRA does not include any specific enforcement procedures for MSW. This is not surprising, given the currently limited Federal role in this policy area. The only existing mechanism in RCRA for Federal action against improper disposal of MSW is Section 7003 (42 USC 6973), which grants EPA broad authority to bring suits for action against any entity. (as defined by the Act) whose "past or present handling, treatment, transportation or disposal of any solid waste [including MSW] or hazardous waste may present an imminent and substantial endangerment to health or the environment."

Such suits might help States or localities bring about necessary, but politically difficult, actions (e.g., denying a permit to expand a landfill known to be hazardous, but which offers the only readily available capacity), or might correct State actions inconsistent with the stated goals of RCRA. To date, EPA has made limited use of this authority, consistent with its general deference to States on MSW issues.[15]

Option 1: Define a Stronger Enforcement Role for EPA

Congress could define a stronger enforcement role for EPA by requiring that Federal permits be issued for the handling, treatment, and disposal of MSW. If Congress were to choose this option, it would also need to address how to coordinate Federal enforcement efforts with those of State and local governments. This option has several implications. First, it raises the question of how a Federal permitting program would be structured. For example, EPA's air and water programs are designed so EPA delegates the actual permitting and enforcement authority to the States but reserves the right to oversee the permitting process, take enforcement actions, and take over programs that are not functioning properly. Substantial resources would be needed for EPA to enter the MSW arena and develop standards and guidelines, administer the programs, and undertake vigorous enforcement actions.

Congress also could address the levels of civil and/or criminal penalties that can be assessed for violations of existing and future Federal requirements. Some States are increasing the civil and criminal penalties for improper waste management and are placing high priority on enforcement actions because they fear that the increased costs of complying with new MSW regulations could lead to increased illegal disposal. *Vigorous enforcement and imposition of stiff penalties are necessary to provide a strong disincentive for improper management.* The ability of citizens to sue the Federal Government for lack of enforcement (Section 7002) also is a potentially important mechanism to ensure Federal implementation of existing regulations.

Improving the Flow of Information

The success of any national effort to adopt a waste prevention and materials management policy and manage MSW effectively will de-

[15]See box B, as well as RCRA Section 4005(c).

pend heavily on the quality and dissemination of key information. "Information" is broadly conceived to include not only knowledge and data needed by decisionmakers about the generation of MSW and management of materials, but also adequate education and research efforts.[16]

Option 1: Information Clearinghouse

Legal authority to create an information clearinghouse already exists in RCRA (Section 8003), yet one has never been established. Although EPA has plans to establish one (EPA 1989), Congress could specify a timeframe for doing this and address the functions of the clearinghouse. Alternative approaches also are available, for example, establishing a quasi-governmental organization based on a cooperative agreement among government, business, and the public. Such an organization could perform several functions, perhaps more efficiently and flexibly than a government clearinghouse. Regardless of the form chosen for the clearinghouse, the centralization of MSW information programs could help reduce the duplication of effort now occurring as more and more communities reconsider MSW collection and attempt to control increasing management costs.

To aid MSW prevention efforts, the clearinghouse could offer technical and economic data on labeling, MSW generation, sources of toxic substances in MSW, trends in products and packaging, and actions that individuals can take to reduce MSW generation. This information could help consumers and public interest groups identify ways to change their purchasing decisions, and it could help industrial producers, especially smaller companies with limited technical resources, make use of techniques developed by others. For example, information about certain kinds of product design changes and chemical substitutions might be transferred across products and industries, assuming the information is not proprietary.

With respect to recycling, a clearinghouse could provide information and assistance on: 1) specifications regarding secondary materials quality and methods for ensuring quality control; 2) secondary materials prices and production (which could be provided by the Department of Commerce under existing RCRA authorities); 3) technical developments that minimize costs and improve the quality of secondary materials; and 4) collection programs for secondary materials. It also could provide guidance to consumers about recycling different materials, as well as assistance to businesses (e.g., by providing information about recycling networks).

The clearinghouse also could provide performance, design, and economic information for incineration and landfilling. In addition, a clearinghouse could develop procedures to evaluate the costs and effectiveness of different management programs. For example, a computer model that helps communities assess the comparative costs of various management scenarios could be housed and accessed through the clearinghouse.

One key function of a clearinghouse would be to disseminate this information. Moreover, a clearinghouse could foster its collection and compilation, and it could identify and address important information gaps. External activities, such as conferences and workshops, could support these efforts. Special institutes could be established to gather information on specific materials for which information currently is not collected. "Peer matching" programs, similar to those sponsored by EPA in the past, could help communities identify other communities with facilities or programs similar to those which they might be considering.

[16]Many of the institutional structures needed to collect and disseminate information, sponsor research, and encourage education are the same for both prevention and materials management (particularly recycling), which suggests that programs might be most efficient if they address both elements together.

Option 2: Education

The Federal Government also has opportunities to improve education about MSW prevention and materials management. To sustain new efforts in these areas, it is critical that the Nation's children—the next generation of consumers—be well-informed about the entire MSW system and the environmental implications of how the Nation uses natural resources. The links between the extraction of virgin resources and the mounds of waste that are discarded daily must be made more apparent to the next generation than they are to most Americans today. Both manufacturers and consumers need to know how their decisions about products affect MSW generation and management, and what opportunities exist for making changes that lead to MSW prevention or increased recycling. States and localities with established recycling programs usually cite the importance of education—particularly at the grade school level—in the success of their efforts.

Congress could encourage Federal MSW educational efforts through a number of specific options. For instance, EPA and the Departments of Commerce and Education could sponsor conferences with industry and local and State officials to develop educational materials, and EPA could undertake educational campaigns of its own. Congress also could provide funding for educational grants and programs.

The Federal Government also could promote household hazardous waste collection programs to educate citizens about alternatives to toxic products. Public concern over the proper management of household hazardous wastes (e.g., discarded solvents, paints, batteries, and cleansers) is evident, and special collection and management programs for them are increasing throughout the country. Although such programs may be expensive and their significance in terms of risk reduction is not known, they are useful tools for educating the public and manufacturers. Public service advertising could also be used to educate people about MSW issues. One private sector example is a joint campaign by the Environmental Defense Fund (EDF) and The Advertising Council to promote recycling (EDF, Sept. 1988). The campaign uses TV, radio, newspaper, and magazine advertisements.

Option 3: Increase Federal Research

Another option available to Congress is to increase Federal research funding on MSW issues for agencies such as EPA, National Institute of Standards and Technology, Forest Products Laboratory, Bureau of Mines, and the Department of Energy. EPA, for example, listed specific topics that merit additional research in its "Agenda for Action" (EPA, 1989) and is compiling a detailed list of research and development projects as part of a Municipal Innovative Technology Evaluation Program (Greenblott, 1988).

Funding for Federal MSW research should address at least two areas: 1) developing evaluation methodologies to assess the effectiveness of prevention and management programs; 2) exploring innovative methods and technologies for MSW prevention (e.g., developing substitutes for toxic substances, designing products to be more durable or to generate fewer residuals); and 3) exploring innovative methods and technologies to improve MSW management (e.g., new uses for secondary materials, enhanced degradation of MSW in landfills, improved processing techniques for residues from waste management, testing procedures for ash from recycling and incineration facilities).

Funding

An important concern when considering any new Federal policy or program is how such activities will be funded. In general, new or independent sources of funding are desirable, rather than expecting new programs to compete with existing ones for scarce budget dollars. Federal revenues would be necessary to fund many of the Federal activities that Congress

could require for MSW prevention and materials management.

Funding for planning and implementing MSW prevention and management programs, of course, needs to be developed by all levels of government. Some funding mechanisms used at the State level could be applied at the national level as well, perhaps more effectively. Other funding options might be more appropriate or feasible for State and local governments, or for any level of government, to apply.

Federal options for raising revenues are available. These options include fees on packaging and/or other products, user or "waste-end" fees, and a national income tax. *Such fees, in addition to raising funds for MSW programs, possibly could help internalize the costs of waste generation and management, if they are set at high enough levels.* For example, high fees might create an incentive for manufacturers to consider the impact of products on the waste stream when they are designing new products.

Fees of any sort are likely to be discriminatory, since it is cumbersome to apply fees on all parts of the waste stream equally. They also can be difficult to administer, given the number of entities potentially subject to the fees (e.g., manufacturers, retailers, distributors, consumers). Some types of fees may be better able to overcome these obstacles than others.

Option 1A: Product Fees

One option is to impose a fee either on the virgin materials used in packaging and containers or on the packages and containers themselves. Proposals have been introduced in several states, for example, to impose a tax on packaging and containers, with the level of the tax varying based on whether a product is recyclable and/or made of recycled materials. In addition, requiring products to be labelled accordingly would help consumers make purchasing decisions based on these considerations. The advantage of this approach is that the fee also might affect decisions regarding product design and manufacturing.[17] In addition, this fee could generate significant revenues, although it is not clear whether a decrease in MSW generation or an increase in recycling would occur as a result.

Because packaging and containers are estimated to account for about 30 percent of the waste stream by weight, this is a selective or discriminatory measure. However, a fee based on a specific subset of products can be justified as consistent with the goals of prevention and materials recovery. It can be argued that packaging and containers are a significant, visible, and problematic portion of the waste stream and therefore warrant such discriminatory measures. A more equitable proposal is a fee on *all* products that become MSW. However, this approach would be cumbersome to administer because of the large number of products and manufacturers involved.

Option 1B: User or Waste-End Fee

In contrast to these "front-end" approaches, a user or "waste-end" fee could be charged on a weight or volume basis when MSW is sent to management facilities. Some communities and States already administer such fees for particular facilities or for "problem wastes" (e.g., tires and batteries), and they use the fees to fund research and special management programs.

If a waste-end fee was applied to all MSW sent to management facilities, and consumers were billed directly (at households and commercial establishments) by the waste haulers to recover the fees, it could create an incentive for consumers to consider the quantity, durability, and even toxicity of products. In turn, changes in consumer decisions could pressure manufacturers to address the potential for MSW prevention when products are designed and manufactured. Moreover, if the administering govern-

[17]The specific rate per ton for this or any similar fee could be based on the level of funding needed to support various activities. OTA makes no judgment in this report on what funding level would be needed.

ment wished to promote one management method over others, it could alter the fees as necessary. It is not known how large user fees would have to be to accomplish these goals. Furthermore, given that the amount needed to promote a particular method is likely to vary locally, such an approach is likely to be most feasible at the local level.

Concerns have been raised that user fees could lead to illegal disposal by consumers or haulers. However, some evidence exists that consumers will respond to increased waste disposal charges by changing their purchasing decisions and, for example, recycling more MSW (Riggle, 1989).

Option 1C: National Income Tax

Another possible option would be to establish a special income tax paid by all citizens. Although an income tax may not be politically feasible, even at a low rate it could raise significant revenues. For example, over $300 million would be raised annually if the rate charged was $1 per person for an individual or family with an adjusted gross income of less than $25,000 and $2 per person for higher incomes. This option is equitable—every person produces garbage. Distributing these tax revenues to various MSW programs also could be justified by potential future reductions in management costs to the public and an improved environment. Moreover, this system would be administratively simple to implement. While it could be referred to as a waste generation fee, rather than a tax, one disadvantage is that it could be viewed as setting an unwanted precedent for establishing taxes linked to specific issues.

Specific MSW Program Options

Waste Prevention

Reducing the amount or toxicity of MSW is a *preventive* action, and thus it has a fundamentally different function from waste management.[18] *Reducing MSW generation and toxicity offers many potential benefits*—fewer environmental problems with waste management, lower waste management costs, increased conservation and efficient use of resources (including materials, energy, and land associated with waste generation and management), and increased public confidence in government MSW policies and in industry.

Several obstacles have precluded substantive waste prevention efforts to date. Some of these are cultural or economic (i.e., market-driven). For example, one deterrent is that manufacturers have little incentive to consider the problems or costs of MSW disposal when they design and make a product because most products do not become waste until long after leaving a factory.[19] Similarly, individual consumers currently have little economic incentive to consider the implications of their purchasing and consumption patterns.[20] Another consideration is that reducing MSW generation is inconsistent with America's demand for convenience and disposable products and, for that matter, for all types of products (box A). Containers and packaging, which are mentioned frequently as potential targets for waste prevention efforts, are a large and visible part of MSW, but they serve many functions (e.g., sanitation, theft prevention, public safety, weight reduction, customer appeal) that must be considered.

[18]The precedent for prevention efforts exists with hazardous wastes (OTA 1983, 1986, 1987a). Although MSW probably is not as great an overall threat to human health and the environment, the Nation has an opportunity to shift its thinking toward a more preventive mode for MSW as well.

[19]This is different from the situation with industrial wastes, especially hazardous wastes, produced at a manufacturing plant itself. In that case, the waste comes directly from production processes and disposal costs can be linked directly to the processes. Products and materials only become MSW, however, after they have been used for some purpose.

[20]This is in part because MSW management costs usually are paid either through municipal taxes that cover many services or by institutions and businesses, not by individuals. Even if costs rise, there is no assurance that they will reach a sufficiently high level to cause changes in consumption patterns.

The likelihood that production and consumption patterns will change hinges on behavioral and cultural attitudes, as well as economic considerations, and thus it is difficult to estimate whether and when prevention, particularly in terms of quantity, might have a significant effect on MSW. Also, since there is no standardized way of defining and measuring prevention, it can be difficult to know when it has occurred.

Prevention and recycling efforts can sometimes work at cross purposes. For example, multi-component "barrier" plastic bottles (i.e., bottles made of several layers and types of plastics) are now being used for products such as ketchup and syrup. Although this design reduces the weight of waste generated, glass bottles can be more readily recycled. The new plastic bottles are complex mixtures and can only be recycled into items such as lumber substitutes, and few facilities exist to do such recycling.

Another constraint is that State and local officials, the traditional decisionmakers for MSW management, can do little to influence manufacturing decisions or consumer buying patterns. Most products are marketed in more than one State, and officials cannot easily mandate changes in products that flow in interstate commerce. In addition, manufacturers that market products in more than one State can face severe difficulties if they have to meet varying State and local requirements on products and packaging.

Strong Federal actions, however, might overcome the various obstacles to MSW prevention, change general perceptions about its feasibility, and ensure that attention is not focused solely on developing management capacity. Possible options for Federal efforts can be grouped into four categories:

- establish goals for quantity and toxicity reduction, and give prevention high priority within EPA and other Federal agencies;
- provide economic incentives (e.g., grants, awards, procurement);
- improve information flow to the public and manufacturers (e.g., labeling, waste audits, research, clearinghouse); and
- ban specific products or substances.

In addition to these options, another critical activity will be educating manufacturers and consumers about prevention possibilities (see "Education" above).

Option 1: Develop National Goals and Assure Them High Priority

Option 1A: Goals to Reduce the Volume of MSW

Congress could set incremental goals to reduce the quantity of MSW generated and thus help focus attention on the potential offered by prevention. One reasonable goal would be to attempt to offset estimated future increases in MSW generation. Since per-capita generation and population growth are each increasing by about 1 percent annually (box A), an initial prevention goal might be 2 percent per year.[21] Such a goal symbolizes a long-term commitment, yet it should not prove disruptive to the economy or consumers. If this could be achieved, the volume of MSW generated would remain constant and local officials would have to manage the same amount of MSW as they do now.

Setting such a goal raises several problems, however.[22] First, how would quantity reduction be measured on a national basis? Given the range of uncertainty in estimates about MSW generation, any change on the order of 2 percent would be overwhelmed by estimating errors, and it would not be clear whether a real change

[21]The 2 percent figure is an example of a goal, not an indication of how much prevention is possible.

[22]These problems also are associated with setting goals for any management method (e.g., see "Recycling" below).

had occurred.[23] Second, even if quantity reduction (and associated savings in waste management costs) could be measured, it would still be difficult to resolve all potential tradeoffs, particularly to quantify other potential benefits (e.g., using less materials and energy) and costs (e.g., effects on GNP and convenience) offered by prevention and to assess the performance and effects of new or alternative products. Quantity reduction also has to be evaluated in terms of its effects on MSW toxicity; for example, using cadmium-coated bolts to reduce corrosion might make bolts more durable and reduce waste, but it also can increase potential toxicity when the products are discarded in MSW.

Option 1B: Goals to Reduce the Toxicity of MSW

If toxic substances in MSW that pose risks to the public and the environment could be identified and then eliminated from products and materials that become MSW, then recycling, incineration, and landfilling facilities would be safer and conceivably easier to site and operate.[24] This might even abate the need for quantity reduction. In addition, manufacturers might lower their own costs by reducing their use of toxic chemicals in production. Examples reviewed by OTA demonstrate that reducing the amount of toxic substances in some products is technically feasible and is actually occurring, at least on a limited basis.

Many toxic elements serve important functions in products (e.g., cadmium as a heat stabilizer in some plastics). However, it is sometimes possible to identify more benign substitutes (e.g., to replace metal-based inks, synthetic organic pesticides) that are not prohibitively expensive. Identifying targets for toxicity reduction efforts involves distinguishing substances of concern, particular products containing the substances, and likely reductions in toxicity. Thousands of products become MSW, and it is difficult to trace the lifecycle—from design to discard—of substances or their potential substitutes in these products. In many cases, proprietary considerations constrain public evaluations of substitute substances (e.g., a substitute for mercury and cadmium in household batteries). Requiring industry to conduct waste audits might help alleviate these problems.[25]

As an initial goal, Congress could require EPA to identify those metals and organic chemicals likely to contribute significantly to the risks associated with MSW management. EPA could then be required to study a given number of those substances each year.[26] For each substance, EPA could evaluate product sources, technical feasibility of elimination or of substitution with benign substances, effects on potential risks, economic and social costs to industries and consumers, and incentives and/or regulatory initiatives likely to be effective in achieving reduction. This would be similar to EPA's current efforts on lead and cadmium (Franklin, 1989).

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[23]The same might be true for the estimate that per-capita generation is increasing by about 1 percent annually, because it is based on a model of how materials flow through society. In both cases, standardized methods have not been developed for measuring changes based on *actual* generation and collection.

[24]It is important to note, however, that some environmental problems associated with MSW management have little to do with toxic substances in products. For example, methane emissions and acidic leachate are both generated from the natural decomposition of organic materials in MSW (e.g., yard wastes, paper). In addition, small industrial and commercial generators of hazardous wastes can legally dispose of them along with ordinary MSW.

[25]Waste audits, conducted during the design of a product, identify potential byproducts and impacts of production and use of the product on the wastestream.

[26]It has proven difficult for EPA to identify toxic substances in a systematic way for regulation. Alternative approaches that would shift the burden of proof to manufacturers could be considered. For example, manufacturers could be required to evaluate the effect of using a given substance on human health and the environment.

Option 1C: Assure High Priority for MSW Prevention in Federal Agencies

Federal efforts to promote prevention are most likely to succeed if they have high visibility and support, particularly at EPA. Congress could direct EPA to give high priority to MSW prevention efforts. For example, Congress already is considering establishing a high-level EPA office for waste minimization.[27] This office could devote some resources to MSW prevention efforts (e.g., providing grants and awards, establishing an information clearinghouse, analyzing effects of new regulations on the potential for prevention). These efforts are unlikely to entail major costs to the Federal Government. Furthermore, authorizing such spending by EPA would send a signal about the seriousness of Federal efforts.

Congress also could require all Federal agencies to establish a "MSW prevention officer" position. The responsibilities of this position could include promoting prevention, reviewing agency activities with respect to impacts on MSW generation, and coordinating efforts with EPA. The position could also be given similar responsibilities with respect to procurement and recycling, although this might draw some attention and resources away from the prevention efforts.

Option 2: Provide Economic and Other Incentives

Option 2A: Grant Fund

Congress could provide direct economic assistance to projects designed to promote MSW prevention. For example, it could establish a *grant fund*, financed by one of the funding mechanisms discussed above. A grant program could be administered by EPA, an interagency task force, or a national commission. Whatever group administers such a program, it could select projects, review project performance, provide public accountability of the results, disseminate results, and prepare an annual report to Congress.

Activities that might be eligible for grants could include: 1) industrial research and development projects; 2) capital investments to modify manufacturing plants to produce products that create less MSW or have fewer toxic substances; 3) outreach programs to educate consumers about their role in MSW generation and prevention; 4) research projects on removing institutional and social obstacles to prevention; and 5) innovative ideas for use by nonmanufacturing businesses (e.g., retailers, service providers, advertising or marketing companies).

Option 2B: High-Visibility Awards

To focus national attention on MSW prevention and provide incentives for its practice, Congress could authorize annual awards for noteworthy prevention accomplishments. These could be Presidential awards, similar to the Malcolm Baldridge National Quality Awards (P.L. 100-107) established by Congress to motivate American industries to increase their competitiveness through improved product quality. Alternatively, an awards program could be developed and administered by EPA, the Department of Commerce, or a national commission. The range of possible recipients is broad: manufacturers, individual researchers, nonprofit and public interest groups, marketing companies, and government agencies.

Option 2C: Federal Procurement

Federal procurement programs exist to purchase products made from some secondary materials, allowing prices that are slightly higher than those for products made from virgin materials. These programs could be extended to products that generate less MSW or are less toxic, such as water-based inks. Congress could

[27]EPA established an Office of Pollution Prevention, but the primary focus of the office has been on hazardous wastes; in addition, it does not have agency-wide visibility.

explicitly require Federal agencies not to discriminate against such products (except where they are not available or do not meet critical technical specifications) and authorize a 5 percent to 10 percent price preference for such products, a level similar to those in State procurement programs for recycled goods.

The major benefits of such a program would be to: 1) strengthen the leadership role of the Federal Government; and 2) provide an initial market for these products, which could help reduce financial risks faced by manufacturers if they attempt to change product design or composition, or risks faced by service providers trying to change some aspect of how they do business. As with any procurement programs, two important drawbacks exist: defining exactly what products qualify for preferential treatment, and inducing Federal agencies to actually make such purchases.

Option 3: Improve Information Flow

Option 3A: Develop Labeling With Prevention Information

Labels often are used to convey key information or ideas about products and influence purchase decisions (e.g., "no cholesterol" and "no caffeine" labels on many food products). One option is to authorize the use of a special logo on products that are considered to benefit the environment or help resolve waste management problems. In West Germany, for example, the Federal Environmental Agency has given "Environmental Angel" awards to companies for such products (figure 5). The angel logo can then be used by the companies to market the product. Canada is instituting a special label for products that are recycled, recyclable, biodegradable, energy conserving, or free of ozone-depleting substances (Environment 1989), and similar systems are being considered in Norway and Japan (Worldwatch 1989). Similarly, labeling on "reduced waste" products could be used in the United States by manufacturers to gain advantages in the marketplace, by retailers to implement marketing efforts, by procurement offices to determine product preferences, and by consumers to guide purchasing decisions.

Another idea is to use the ratio between the amount of MSW ultimately generated and the amount of useful product (OTA Workshop, July 1988). Other ratios conceivably could be developed to address toxicity, durability, repairability, and reuse. The information could be coded by color, symbol, or numerical ranking, as long as the system was easily understood. However, the information needed to make these judgments (e.g., volume, durability, toxicity, or repairability and reusability) is complex and often unavailable. Congress has several options to address the labeling issue. One approach might be to mandate establishment of design institutes or product review boards, or direct Federal agencies (e.g., EPA, Consumer Products Safety Commission, National Institute of Standards and Technology) to begin developing technically sound methods to rate products on MSW-related criteria.

Alternatively, a commission or advisory panel could be appointed to study and make recommendations regarding labeling programs. To ensure that the recommendations are turned into actions, Congress could give the commission a blue-ribbon status and require the EPA Administrator and Secretary of Commerce to review and implement the recommendations, unless they could demonstrate sufficient reason for not doing so. The commission could assess standardized ways of defining and measuring prevention, types of labels, criteria for labels, categories of products to target, how to determine success (in terms of actual toxicity or quantity reduction), past labeling efforts, educational opportunities, social and economic costs of labeling and prevention, and how to address imported products (e.g., legal or trade agreement limitations to labeling requirements on imports; whether data on toxicity could be required).

Option 3B: Data on MSW Generation

Federal prevention efforts will need accurate and up-to-date information on many aspects of MSW, including the quantity or toxicity of specific products; the impacts of new products and social trends on MSW generation; and the generation of MSW by different sectors (i.e., residential, commercial, institutional). This type of information would be useful for MSW management programs, as well. Congress could direct EPA to establish an ongoing program to conduct specific studies on MSW generation and potential prevention targets; for example, these studies could address:

- the quantity and toxicity of MSW generated by residents and commercial and institutional establishments, especially in terms of different products;
- the effects of educational efforts (e.g., measuring how consumers change their habits when prevention goals are clearly articulated);
- future changes in MSW generation patterns at the community level to gain an understanding of how prevention might help local MSW management;
- targets for prevention efforts, in terms of both quantity and toxicity, and the potential costs and benefits of such efforts.

Industry also could provide important information, particularly about toxic substances. Industries could be called on to perform waste audits or draw up nonbinding plans that identify potentially toxic substances in products, explore the feasibility of reducing these substances, and estimate the costs involved.

Option 4: Banning Specific Products and Substances

A more prescriptive approach to MSW prevention would be to ban products and substances that are considered undesirable.[28] Fast food packaging, some plastic products (e.g., grocery bags, foam polystyrene cups), and packaging in general are lightning rods for public attention and certain types have already been banned in some communities. These bans have strong symbolic value, and the threat of a ban can motivate private sector action to change the composition of particular products (e.g., removing chlorofluorocarbons from polystyrene foam cups).

Bans generally focus on a small portion of MSW. One study found that paper and plastic fast food packaging currently comprises about 0.3 percent by volume of the material excavated at landfills; disposable diapers (which are part plastic and part paper) comprise about 1.5 percent (Rathje et al., 1988; Rathje, 1989). Even so, this still could be useful in achieving the 2 percent goal discussed above. However, it often is not clear whether the replacements for banned products are better in terms of reducing quantity or toxicity or of using fewer natural resources during manufacturing.

Bans or regulations on using specific substances in products that become MSW may have more merit if substitutes can be found that reduce toxicity. Congress could require EPA to identify additional substances of concern and assess the effects of banning or regulating these substances pursuant to its existing authority under the Toxic Substances Control Act (TSCA).

Recycling

The current level of MSW recycling in the United States is low, about 10 percent. Although it is difficult to say how much recycling is possible, most people agree that recycling can be increased. Substituting recycled or "secondary" materials for virgin materials conserves natural resources. It also can result in varying amounts of energy savings, depending on the product and material involved.

From a national perspective, recycling is attractive and deserves precedence over incin-

[28]The use of taxes or deposits to help improve the management of such products and substances is discussed in "Recycling."

eration and landfilling because it can contribute to national goals such as energy and materials conservation. From a local perspective, recycling is attractive because of its potential to divert at least some materials from landfills or incinerators, which helps conserve available capacity; it also can reduce waste management costs and reduce risks to human health and the environment in some cases.

The materials management aspect of the MSW policy suggested in this report provides a framework for considering these benefits and recognizing the potential value of material resources contained in MSW. OTA has identified certain constraints to the collection, processing, and manufacturing of secondary materials (see, for example, box E) that could be reduced by government intervention. Many State and local governments and businesses already are addressing some of these limitations. Many of these efforts have been successful, particularly those related to collection, but the actual rate of increase in recycling at the national level has not been determined.

EPA is promoting an initial national recycling and prevention goal of 25 percent by the year 1992. Some cities already appear to be recycling more than this, and proponents suggest that much higher rates are possible (e.g., ILSR 1989; CBNS 1988).[29] It is safe to say that more efforts are necessary to reach that goal nationally. Although such a goal is a useful target, it does not appear to be based on a quantitative evaluation of market potential. The actual amount that recycling can be increased on a national level is not easily predicted, nor is such a prediction particularly worthwhile given the dynamic nature of materials markets.

Translating any specific national goal for recycling into action requires a close look at recycling rates for each material component of MSW. Rather than setting percentage targets for the amount of material that should be recycled, it may be more realistic to set targets for *progress* (e.g., surpassing historical rates of increase in recycling of a given material). Requiring progress rather than specific recycling rates would free planners from having to determine total market potential and would make how the baseline level of recycling for each material is calculated less important. Targets for progress could be set for each material based on economic conditions and relevant technical factors; box F indicates, on a qualitative basis, where market expansion appears particularly promising. Figure 6 presents estimates of current recycling rates for particular materials in MSW.

Regardless of the manner in which targets are set, *it is important that flexibility be maintained to allow recycling programs to be designed for local conditions.* In general, markets for secondary materials fluctuate considerably over time, often rapidly. *The ability to sustain marketing of collected materials at high levels cannot always be assured. The dynamic nature of markets is a key factor affecting the reliability of recycling as a MSW management alternative.*

This conclusion has important implications. If many communities around the country decide at roughly the same time to collect secondary materials and market them to reprocessors and manufacturers, prices for those materials may drop and some communities may be unable to market the materials they collect. In these cases, communities may have to pay an additional cost to landfill or incinerate the materials, pay reprocessors or manufacturers to take the materials, or store the materials temporarily.

[29] A recent report identified 15 communities, both large and small, that recycled more than 25 percent of their waste (ILSR 1989). However, while it is likely that these communities are recycling large amounts of their MSW, the estimates in many cases include more than MSW (e.g., construction debris, wood chips), as defined here. For example, Islip, New York, the city infamous for the Mobro garbage barge, is estimated to have a recovery rate of 32 percent. When construction debris is deleted, the estimate drops to 25 percent. This points out, once again, the problems involved in defining MSW and in calculating and comparing overall recycling rates.

Within this context, opportunities for government intervention to stimulate recycling exist in the following areas:

- information and education (e.g., clearinghouses, technical assistance, advertising, awards);
- research and development (e.g., grants, loans);
- development of standardized definitions, testing procedures, and labeling systems;
- development of health and environmental regulations for recycling facilities;
- market development (e.g., procurement programs, direct subsidies to industries to use secondary materials, local economic development, export markets);
- fees and pricing policies (e.g., changing prices and subsidies for other management methods; product charges); and
- regulatory actions (e.g., requiring secondary materials recovery, banning materials from landfills, national deposit legislation).

Although some of these actions may be most appropriately addressed by a particular level of government, many can be addressed at all levels—Federal, State, and local. Specific options within each of these areas are discussed below.

Option 1: Increase Information and Education

Information is critical to increase the ability of consumers and businesses to make decisions regarding recycling and recycled products. Currently, the Federal Government (through the Departments of Commerce, Interior, and Agriculture) provides detailed information regarding production, consumption, and prices on many virgin materials, including aluminum, steel, and wood products. However, similar information for many secondary materials is difficult to obtain, particularly historical information.

Option 1A: Improve Collection and Dissemination of Information

Congress could require Federal agencies (including the Department of Commerce, under existing RCRA authorities) to increase the collection and analysis of data on consumption, production, and prices of materials recoverable from MSW. These data are available from industries in most cases. This option, then, would only entail expanding the coverage of current data series and would not require new programs, although it might require additional funding. The information could be published in monthly and annual reports, which could be disseminated through a clearinghouse. Interagency working groups could be formed to identify new information needs and delegate collection responsibilities.

Option 1B: Increase Education

Educational programs can raise environmental consciousness and help consumers identify materials that can be reclaimed from their trash cans, as well as increase awareness of how materials are used in society. Programs aimed at elementary schools can provide long-term benefits by instilling the ideas of materials and energy conservation in young people. Education is primarily a local and State function, but the Federal Government could assist in several ways. For example, Congress could direct EPA to renew public outreach programs or specify that some portion of any grants to States be given to communities for education programs. Education also can be achieved through information provided on product labels.

Option 1C: Awards for Product Design and Labeling

Another information incentive would be to give awards or grants for innovative product design (e.g., designing existing and new products to be recyclable, as advocated by some public interest and environmental groups), new recycling technologies, and labeling systems.

EPA or the Department of Commerce could develop guidelines on how to evaluate products for awards and projects for grants.

Option 2: Research and Development

Many industries, including paper, glass, aluminum, steel, and, more recently, plastics, undertake research to enhance reprocessing capabilities, yet technologies still do not exist to adequately reprocess some materials, such as non-color-sorted glass. Technological limits also inhibit some secondary materials manufacturing processes (e.g., waste paper de-inking), and additional research could help remove them. Although some improvements are occurring (e.g., for recycling of polystyrene), technical refinements and capacity expansion take time and money. Furthermore, information developed by industry is often proprietary, thereby limiting the spread of innovation. Private industry rarely researches product design with recycling as a criterion, although this also is changing. For example, the Society of Packaging Professionals is preparing a list of simple criteria to help packaging manufacturers consider environmental effects when they make decisions about materials and containers for products (SPHE 1988).

Government-sponsored research on improvements in reprocessing and manufacturing, as well as design for recycling, could help quicken the pace of technological innovation in this area. In the past, the Department of Commerce, the National Forest Products Lab, and the Bureau of Mines have conducted research on secondary materials. For example, the National Forest Products Lab has been testing new methods to remove contaminants from waste paper (J. Klungness, pers. comm., August 1988).

Congress could encourage new research and development by providing incentives such as tax exempt bonds, low-interest loans, loan guarantees, research grants, and tax credits and exemptions. Low-interest loans and loan guarantees have several advantages: they do not require an immediate Federal revenue source and they are relatively easy to administer. Research grants require additional expenditures, but they are a traditional means of stimulating new research. Congress, for example, could establish research grant programs at EPA or the National Science Foundation. Some grants could be given to public institutions, particularly where the proprietary nature of industrial research limits expansion of recycling capacity. Or, perhaps, joint ventures between national laboratories and industry could be sponsored.

In contrast, tax credits and exemptions can result in lost Federal revenues and, more important, generally have not been proven to be effective. Most Federal tax credits employed in the past have been too small (10 percent to 15 percent) and State tax credits affect too small of a base (because State tax rates are relatively low) to have a significant financial impact on business decisionmaking.

Option 3: Standardized Definitions, Labeling, and Avoided Cost Calculations

The absence of a standardized language for recycling and recycled products hinders communication and understanding among consumers, reprocessors, manufacturers, and communities. The Federal Government has opportunities to clarify several of these hindrances by providing leadership in the areas of definitions and testing procedures, labeling, and avoided cost calculations.

Option 3A: Standardize Definitions and Testing Procedures

Standardized definitions and reporting methods for determining "recycled content" and "recyclability," along with standardized procedures to test the performance of secondary materials, would help consumers and manufacturers make decisions about secondary products and materials. Congress could instruct EPA or the National Institute of Standards and Technology to develop standardized definitions and

procedures, or to use industry standards such as those being established by the American Society of Testing Materials or the National Recycling Coalition (e.g., Ferrand, 1988). In either case, the information could be disseminated through an information clearinghouse.

Option 3B: Standardize Guidelines for Labeling

Standardized labeling guidelines could be developed to provide information about recyclability and materials content on product labels. Standardized labeling could help transfer meaningful, consistent information to consumers and, in conjunction with education programs, enhance the recognition of recycled and recyclable products. Currently, most products are not labeled to denote secondary materials content or recyclability, although the Society of the Plastics Industry has established a voluntary labeling program to identify the specific resins from which plastic containers are made. Some manufacturers are using the recyclability issue as a marketing tool; standardization could help ensure that consumers receive accurate information. Labels also could be used to denote non-recyclability.

Congress could require EPA or other Federal agencies to begin developing guidelines for standardized labeling of different products. Because the development of any labeling program is likely to be extremely complicated (as discussed above for prevention), Congress could commission an in-depth study of the entire labeling concept and consider legislative initiatives after receiving the report. To ensure that U.S. industries are not unfairly disadvantaged, Congress could extend labeling requirements to imported products.

Option 3C: Standardize Avoided Cost Calculations

The collection of secondary materials can be encouraged by providing collectors with a portion of the net savings (if any) that result from *not* incurring the cost of incineration or landfilling. This savings is known as "avoided cost."[30] When the collector is a community, the community retains the savings because its overall disposal costs are lowered, which provides an incentive for recycling. The main problem with implementing the avoided cost concept widely is the absence of an accepted calculation procedure, which makes it hard to evaluate competing claims about the costs of different waste management scenarios.

Several methods to calculate avoided costs have been suggested (Oregon DEQ, 1986; Berkman and Dunbar, 1987; Crew and Kleindorfer, 1987). Congress could direct EPA to develop a standardized procedure to ensure that appropriate "avoided costs" were used by all. The calculation could include parameters such as current landfill costs, trash collection and transfer costs, environmental costs of collection and disposal, the opportunity cost associated with tying up land as a landfill, and the discounted capital cost of developing a new landfill (i.e., when recycling occurs and conserves landfill capacity, a savings arises as the cash outlay required to construct a new landfill is pushed further out into the future). The avoided cost has to be compared with costs for collecting and processing secondary materials, all of which will change as market conditions vary.

Option 4: Regulations for Recycling Facilities

Manufacturing processes that use secondary materials generate various residuals such as air emissions, wastewater discharges, and solid waste sludges. Many of these processes are regulated to some extent. For some, however, such as facilities that process commingled recyclables, specific regulations and acceptable practices have not been developed. At the same time, other regulatory activities, particularly

[30]The use of an avoided cost calculation involves the explicit comparison of the economic value of materials and energy with the cost of land disposal; these cost comparisons will change over time.

those concerning certain hazardous wastes, have disrupted the recycling system. Both of these issues are appropriate for consideration at the Federal level.

Option 4A: Ensure Adequate Regulation of Recycling Facilities

Recycling facilities (including ones for composting) should be regulated to ensure that they do not threaten human health and the environment, just as other management facilities or manufacturing processes are regulated. Congress could require EPA to ensure that regulations (i.e., standards for design, operation, and residuals; permitting and reporting procedures) extend to all recycling facilities, including those that initially process secondary materials. Such regulations would be an important component of a comprehensive Federal MSW policy, and OTA's suggested management approach is based on the assumption that all management methods are designed to ensure adequate protection for human health and the environment. Failure to ensure adequate regulation for recycling facilities could create expensive problems in the future and increase the level of uncertainty regarding the potential for recycling.

Option 4B: Resolve Conflicts With Hazardous Waste Regulations

Regulations regarding the management of hazardous substances (e.g., lead in batteries and PCBs in washing machines, refrigerators, and other appliances) have caused some recyclers to stop accepting these products because of fears about liability and because of increased costs of complying with the regulations. In some cases, this leads to improper disposal of the products. This illustrates the need for careful consideration of the effects of hazardous waste and other regulations on recycling. Congress could direct EPA to clarify current regulations regarding the recycling of products known to contain hazardous materials, and to identify other products that might cause similar problems in the future (e.g., sodium azide in automobile air bags). EPA could begin developing guidelines for the proper handling of these kinds of products before any regulations take effect, to avoid disruptions in the recycling chain. EPA also could analyze the effect of developing regulations to restrict the use of certain materials in the manufacture of products when they pose similar problems.

Option 5: Market Development

Obviously, it serves no purpose to collect materials for which there is little or no demand (e.g., mixed plastics and mixed paper). While successful government intervention in commodity markets is difficult because of the many complex factors affecting supply and demand, several options are available to the Federal Government to help develop markets: expanded procurement, direct subsidies, economic development initiatives, and building export markets.

Option 5A: The Government As Market Maker —Procurement Programs

The most direct government approach to create new and expanded markets is to buy recycled products. This could be significant, because local, State, and Federal Governments purchase about 20 percent of the goods and services produced in the U.S. economy. In 1976, Congress directed EPA to develop guidelines for procurement of recycled materials (Section 6002 of RCRA), but EPA did not issue any final guidelines until 1988. Guidelines now exist for the procurement of some goods produced with secondary materials (fly ash in cement and concrete, paper products, retread tires, re-refined oil, and building insulation that uses secondary materials). These products are made from demand-limited materials, with the exception of recycled printing and writing paper, which is probably the most visible recycled product purchased by the government.

Congress could direct Federal agencies to increase their procurement programs for recycled products, particularly of additional demand-limited materials (e.g., old newspaper, mixed

waste paper, compost). The difficulties in expanding such programs, however, include developing guidelines about what constitutes recycled products, ensuring that agencies purchase the products, and minimizing the number of specifications for the same product that a manufacturer has to meet. In addition, it is unclear whether procurement has a substantial effect on stimulating increased recycling, although the educational effect usually is considered positive.

Additional provisions could allow private manufacturers to petition Federal agencies to purchase a product made from secondary materials instead of products made from virgin materials, and to require such substitutions unless the recycled products do not meet specifications (Kovacs 1988).

Option 5B: Direct Subsidies

Congress could provide direct subsidies to manufacturers to increase their use of secondary materials. For example, EPA (or a State using Federal grant money) could provide a direct subsidy such as a loan guarantee to a newspaper publisher to construct a newsprint mill that uses old newspapers. This type of subsidy has one major advantage—it can be targeted at specific problem materials in specific locales. It directly attacks the problem of insufficient demand (in this example, by assuring the construction of a facility that will need old newspaper), while at the same time guaranteeing a ready final market (e.g., a newspaper printed on recycled newsprint). However, competitors who have made investments without the benefit of a Federal grant might consider such a subsidy inequitable.

Option 5C: Economic Development

Efforts to build markets for recycled materials can provide economic development opportunities for State and local governments. Although the Federal Government has reduced its involvement in local economic development activities, this option remains important from the perspective of many communities. By coupling local economic development with secondary materials processing facilities, the community retains more control over the market than if the materials were consumed outside of the area. In addition, the community benefits directly because the increase in processing and manufacturing activity stimulates employment, tax revenues, and economic growth. Numerous mechanisms are available to States to promote business development, including low interest loans, loan guarantees, government equity partnerships, and direct grants (Hemphill, 1988; ILSR 1987).

Option 5D: Building Export Markets

Demand for secondary materials also could be increased by developing foreign markets. Current government programs that promote exports in general could be modified to address exports of secondary materials. For example, the Department of Commerce manages the Export Trading Company Act of 1982 (P.L. 97-290), which allows companies to operate as joint ventures and market larger quantities of products abroad without being subject to antitrust restrictions. Congress could direct the Department of Commerce to apply the provisions of this act to assist exporters of secondary materials. The Department also could be directed to identify foreign markets for recycled materials as part of its data-gathering responsibilities.

Although export markets are important outlets for many secondary materials from the United States, they are less stable than domestic markets. In addition, foreign manufacturers gain the benefit of U.S. citizens' and communities' efforts to separate and upgrade the quality of these materials. They also realize the value added when they manufacture new products. Often, foreign products made from low-cost secondary materials present stiff competition for U.S. producers.

Option 6: Fees and Pricing Policies

Fees or changes in current pricing policies could be imposed on different parts of the MSW generation and management system to stimulate recycling. These include fees to stimulate rates of progress in increasing recycling, disposal fees to change the costs of other management methods, and product charges.

Option 6A: Rate of Progress Fees on Manufacturers

If Congress were to set target goals to increase recycling of individual materials, it could encourage compliance by imposing a fee on those manufacturers or industries which fail to make adequate progress (e.g., achieve a certain percentage of recycled material in a product) by a specified date. A similar fee mechanism has been employed by the State of Florida in its new recycling legislation.

Option 6B: Increasing the Cost of Alternatives

If Congress or the States required that a user fee be assessed for using landfills and incinerators, the increased costs to haulers (who probably would be paying the fee) most likely would be passed on to their customers (who generate the waste). If the fee was large enough, it should make materials recovery more attractive economically. However, as mentioned earlier there are problems with such a system. Briefly, it would be difficult to determine the size of the fee to account for regional variation and to administer the fee on a national level. Several States have instituted successful disposal fees for waste delivered to landfills, including New Jersey and Illinois. Another application of this option at the local level might be to impose a higher pick-up fee if consumers fail to participate in curbside seperation for recycling.

Another way to indirectly influence waste management is to remove existing subsidies that promote or require the use of virgin materials. For example, substantial Federal tax incentives encourage the use of virgin materials, despite strenuous attempts to remove them from the tax code during the 1986 tax revision. One remaining incentive is the mineral depletion allowance, which allows mineral producers to deduct from 5 to 22 percent of the value of minerals produced when they compute their taxable income from a mineral property.

Whether this option would be effective is uncertain. Data from the 1970s indicate that removing the incentives may not significantly affect secondary materials markets. It may be useful to review the effects of virgin materials subsidies under current economic conditions to determine whether the conclusions of the earlier analyses still hold. Thus, Congress could direct the Departments of Commerce, Interior, Transportation, and Agriculture to analyze the effects of eliminating virgin materials subsidies on the recovery of secondary materials and on the virgin materials industries themselves, including effects on international competitiveness. From this, a more definitive conclusion about the benefits and costs of such subsidies could be drawn.

The effect of the Public Utilities Regulatory Policy Act (PURPA) on the development of waste-to-energy facilities and on recycling also could be considered. PURPA provides for the guaranteed purchase of electricity generated by small, non-utility generators (including, but not limited to, waste-to-energy facilities), at a rate equal to the cost of a utility itself generating that electricity (OTA 1983). That rate, called avoided cost, is determined by each State. Some people consider this to be a form of subsidizing waste-to-energy facilities. Removing this provision, however, will not necessarily result in less incineration and a subsequent increase in recycling. Waste-to-energy facilities could continue

to sell electricity at going rates, sell steam instead, or raise tipping fees to cover losses in revenues.[31] Removing the provision also could harm other co-generators, which might pose problems if the nation's energy picture changes for the worse. The Federal Energy Regulatory Commission is already considering restricting the definition of avoided cost to remove the difference between the going electricity rate and the rate paid to small generators, which would render the issue moot.

Option 6C: Product Charges

Products can be designed to be more easily recycled, a concept termed "design for recyclability." Congress could place a tax on difficult-to-recycle products to provide an incentive for such design.[32] Such a tax, which should be levied on the manufacturer for optimal effect, would have to be large enough to influence product design decisions. The size of the tax required to induce a manufacturer to redesign products will differ for different products.

Option 7: Require Secondary Materials Recovery and Reprocessing

The Federal Government could more aggressively promote secondary materials recovery and reprocessing by the following methods: 1) requiring deposits on recyclable or problematic products; 2) requiring that post-consumer secondary materials be used to the extent technically feasible in place of virgin materials[33]; 3) requiring communities to establish separation programs; 4) banning products that are difficult or impossible to recycle; 5) banning certain materials from landfills or incinerators; and 6) acting as a buyer of last resort and creating a national stockpile of secondary materials.

These options undoubtedly could be used to increase recycling, but all would likely entail significant costs to other sectors of the economy. Mandatory recycling approaches such as these should be undertaken only after clearly understanding the full range of their social and economic costs. For example, mandating that secondary materials be used in manufacturing to the extent technically feasible, regardless of their costs relative to virgin materials, would increase markets for secondary materials but would disrupt markets for virgin materials. The costs to the virgin materials industries should be considered before implementing such a policy. In addition, to ensure that the competitiveness of U.S. industries is not harmed, imported products would have to be subject to similar provisions. Of all these options, only deposit systems have received much scrutiny. For this reason, deposit legislation is discussed here to illustrate the complexities associated with adopting such options.

Deposit Legislation

Proposals for a mandatory deposit system for beverage containers appear before Congress annually, and they are designed to address a variety of issues including litter control and energy conservation (OTA, 1979).[34] National deposit legislation recently has been proposed in Congress as a means to increase the recycling and reuse rates of beverage containers. The nine States which have deposit legislation (figure 7), however, adopted it primarily because of concerns over litter control. In general, beverage container deposit systems capture between 70 and 90 percent of the targeted containers and appear particularly effective in reducing litter (Belasen, 1988). Data reported by several States with deposit systems indicate that total roadside

[31] A tipping fee is the price paid by a waste transporter to have the waste managed at a particular facility.

[32] Some proposals in this option category also would ban certain products. With respect to plastics, for example, one purpose of the bans is to encourage manufacturers to use plastics that can be recycled or will degrade and to use other recyclable materials, or to use plastics that can be incinerated without forming hazardous compounds. It is not clear, however, that substitute materials necessarily will be more compatible with recycling.

[33] A recent move by one EPA Region to include recycling as a condition in a permit for a new incinerator (see "Incineration" below) could signal an additional way for Federal involvement in mandating secondary materials recovery.

[34] Deposits could also be applied to other types of materials in MSW, for example, car batteries and tires. These deposits could be incorporated into the price of a new car, as well as into the cost of replacement batteries and tires.

litter decreased between 15 and 50 percent, and beverage container litter decreased by as much as 80 percent (Rozett, 1984; Golub et al, 1985). The impact on the MSW stream, however, is less certain, and its calculation is problematic. New York State estimates that since adoption of their Returnable Beverage Container Law, a Statewide savings of 5 to 8 percent in landfill space has resulted (Golub et al, 1985). Critics of mandatory deposit legislation point out that it has a relatively small impact on MSW disposal problems, given that beverage containers are a small, albeit highly visible, portion of the MSW stream.[35] Curbside programs to collect recyclables can cover a broader portion of MSW and thus have the potential to achieve greater diversion of materials from landfills. In the past, deposit legislation may have stimulated the development of processing facilities and recycling markets, but curbside and other types of recycling programs also have this potential.

One major concern about deposit systems has been the potential to increase costs to consumers, retailers, the beverage industry, and the government. The extent of such increases is disputed (Rose 1982/83; Lesser and Madhavan 1987; Porter 1983). It appears overall, however, that both the benefits and costs of deposit systems are considerable and not out of proportion to each other (Porter 1983; Rozett 1984; Moore and Scott 1983). Studies generally indicate a net gain of jobs and some energy and resource savings, but the rate of price increases for beverages in nonrefillable containers is above normal inflation. Costs for changing over to a system for returnable/refillable containers might be high for the beverage industry, but could be at least partially recovered within a few years (Moore and Scott, 1983; Rozett, 1984). Deposit systems also can internalize the disposal cost of beverage products, as can curbside collection programs.

In some States with deposit legislation, such as New York, Massachusetts, and Connecticut, curbside collection programs also are being adopted. California and Florida have adopted modified versions of mandatory deposit or redemption legislation.[36] In 1987, California enacted a redemption law for beverage containers that mandates the establishment of "convenience" buy-back centers for recycling. Yet the financial stability of the convenience centers, administrative burdens associated with implementing the program, and other difficulties are creating concern over the viability of this approach.

In 1988, Florida adopted a deposit-fee system that affects all types of containers, not just beverage containers. As of October 1, 1992, a disposal fee of one cent will be levied on any container sold at retail which is not recycled at a 50 percent rate in Florida. The fee will increase to two cents if the 50 percent target is not met by October 1, 1995. The inclusive scope of materials covered by the Florida law is generally viewed positively, but it is too soon to judge how easily this program will be implemented.

Proponents of mandatory deposit systems argue that statewide or nationwide consistency is desirable, that the costs of disposal are internalized on the industry and consumers (rather than to all taxpayers), and that deposits could be used for a variety of purposes (e.g., managing particularly difficult-to-dispose-of items). However, States are independently devising programs to encourage recovery of materials from MSW, including deposit, redemption, and/or mandatory recycling programs, as appears most appropriate for their particular circumstances. In this light and in the interest of

[35]Beverage containers overall constitute 6 to 11 percent of MSW on a national basis. Most deposit legislation covers a smaller portion of MSW, approximately 5 percent, because some types of containers are not included (e.g., for wine, liquor, and milk).

[36]It is not clear whether recycling programs are negatively affected in States which adopt a deposit or redemption law (e.g., California), or whether the adoption of mandatory recycling in States which already have deposit laws (e.g., New York) is detrimental to overall effectiveness of waste management.

maintaining flexibility at the Federal level with respect to recycling strategies, it is not clear whether it is desirable at this time for Congress to adopt national deposit legislation or any other single approach to encourage materials recovery and recycling.

Incineration

The role of incineration is one of the most contentious issues in MSW management. Public opposition to incineration has grown dramatically in many communities because of concerns about the presence of metals and undesired chemicals in emissions and in the ash residues. In addition, incinerators often are expensive for municipalities, and the potential for stricter regulations on air emissions and ash disposal will increase both the financial risk and cost of new incinerators. These factors have caused some cities to postpone or cancel plans for incinerators.

At the same time, however, incineration is attractive because it treats MSW (e.g., destroys pathogens), can be adapted to recover energy, and greatly decreases the amount of material that must be landfilled. Also, newer facilities that use up-to-date operating procedures and pollution control technologies are capable of emitting much lower concentrations of pollutants into the atmosphere than are older facilities. This abatement of air pollutants, however, puts more pollutants in the remaining ash; as a result, some environmental groups contend that certain forms of ash should be managed as hazardous wastes.[37]

A national policy based on prevention and materials management would promote opportunities to reduce the concentrations of pollutants in emissions and ash. If the strategies outlined in this report were implemented, products in MSW would ideally be composed of fewer toxic substances, and non-combustible materials such as glass or metals would be separated for recycling and/or landfilling and would not enter furnaces. Yard wastes would also be separated for composting, which would alleviate problems with moisture control and nitrogen oxide emissions at incinerators. Communities could then use incineration and energy recovery to manage some of the non-recyclable portions of MSW, and possibly to manage materials collected for recycling when markets for those materials are depressed.

The use of incineration may increase during the next few decades, but to what extent is very unclear. Over 160 MSW incinerators (including about 120 waste-to-energy facilities) now combust about 10 percent to 12 percent (by weight) of the MSW generated in the United States; about one-fourth of this remains as ash that must be managed in other ways (primarily disposed of at landfills). About 45 facilities were under construction as of spring 1989, and plans to build additional facilities have been negotiated in some communities. If all of these are actually built, the portion of MSW that would be managed at incinerators is estimated to increase to about 25 percent by the end of the century (including the remaining ash).

Nevertheless, it is not clear how much new incinerator capacity will actually be developed. There is evidence that the rate at which plans for increased incineration capacity are being canceled is greater than the rate at which new capacity is actually being developed. In addition, the costs of future facilities will depend on what pollution controls and operating procedures are required by permitting authorities. Some States have issued specific regulations for incinerator emissions and ash, but these regulations vary widely. A few Federal regulations apply to emissions (e.g., for particulate matter; in addition, "New Source Review" and "Prevention of Significant Deterioration" evaluations are conducted by the States under the provisions of the Clean Air Act), but MSW incinerators

[37]The uncertainties about ash (e.g., whether it is worse than non-incinerated waste, how much it contributes to leachate problems) cannot be resolved easily with current information, yet there are some decisions that can be made about managing ash that do not require final resolution of the uncertainties.

generally are not subject to Federal regulation. EPA is scheduled to propose regulations concerning emissions in late 1989, but it will not propose guidelines or regulations for ash management until Congress clarifies whether or not ash should be managed as a hazardous waste.

Thus, considerable uncertainty exists about what will be required in the future. There is a general consensus that Federal regulations should be finalized as soon as possible to help reduce this uncertainty. This would provide: 1) a consistent national guideline for the development of new facilities; 2) greater assurance to the public that the risks associated with incinerators are being properly controlled; and 3) a rationale for local and State officials to require particular designs and pollution controls. There is, however, debate about how emissions and particularly ash should be regulated. Two issues related to incineration are capacity and siting (see "Ensuring Capacity" above) and the relationship between incineration and recycling.

Option 1: Clarify Ash Management

The first issue that needs to be resolved is whether the "household waste exclusion" applies to ash. This refers to a provision in the 1984 Hazardous and Solid Waste Act amendments (Section 3001(i)), in which waste-to-energy facilities that burn MSW were exempted from regulation as hazardous waste treatment facilities. However, Congress did not clarify whether the ash from these facilities also was exempt from regulation as a hazardous waste. As a result, confusion exists over whether this ash should be managed as a hazardous waste if it fails a standard toxicity test known as the Extraction Procedure, or EP, test. EPA has stated that it will not propose guidelines for ash management until Congress clarifies this issue.

A second issue to be addressed is the lack of guidance on the design and operating standards that Subtitle D facilities (i.e., facilities for managing nonhazardous wastes) should meet for managing ash if and when ash is considered nonhazardous.

Option 1A: Clarify the Household Waste Exclusion

Congress should clarify the "household waste exclusion." If Congress decides that the exclusion *does* apply, then managing ash of any type as a hazardous waste under Subtitle C would be out of the question.[38] If the exclusion *does not* apply, then EPA or Congress needs to specify those conditions under which ash should be managed as a hazardous waste. Congress, for example, could decide whether to *list* fly ash as hazardous, or to use toxicity *testing* as the basis for deciding whether ash should be managed as hazardous.

Listing.—Congress could direct EPA to list fly ash as a hazardous waste because fly ash samples generally fail the EP test. This would eliminate the need for testing. The costs of managing fly ash as a hazardous waste will be more than current costs, although by how much is uncertain. Another uncertainty is whether there is any difference in potential human health risks associated with managing fly ash in a Subtitle C hazardous waste facility, as opposed to a double-lined Subtitle D facility, or even as opposed to managing combined ash in a single-lined Subtitle D monofill.[39]

Testing.—Alternatively, periodic testing could be required and any ash that fails the EP test (or an equivalent) would then be managed as a hazardous waste. This would raise several problems, however. First, there is considerable controversy about the utility of the EP test, and

[38]The two basic types of ash are fly ash, which consists of the small particles that become entrained in gases leaving the furnace, and bottom ash, which is the uncombusted or partly combusted residue that accumulates on the bottom of the furnace. When fly and bottom ash are mixed together, the mixture is called **combined ash**. In this report, use of the word "ash" without one of these three qualifying terms refers to any type of ash.

[39]These facilities differ in the degree to which they provide control over leachate. Facilities with single liners, for example, generally are considered to provide less control than facilities with double liners.

it is not clear whether an acceptable alternative test can be developed. Second, EPA's proposal to lower the maximum contaminant level (MCL) for lead in drinking water (53 *Federal Register* 31516, Aug. 18, 1988) would lower the corresponding limits for lead in EP tests, which in turn means that more ash would test as hazardous.

Option 1B: Decide How to Manage Ash Under Subtitle D

Little guidance exists on the design and operating standards that Subtitle D facilities should meet for ash management. EPA's proposed Subtitle D criteria do not address ash management in detail, and EPA has not indicated whether, and especially when, it might develop specific regulations for ash. Most States have not addressed this issue. As a result, Congress could decide how ash should be managed, in particular whether the standards to be met should depend on the type of ash involved or on the results of toxicity testing. Whether to allow co-disposal of ash with MSW must also be decided.

Specify Facility Standards According to Ash Type.—One approach to ash management is to specify different design and operating standards for facilities that handle different types of ash. This would avoid problems associated with managing ash based on test results and provide an easy basis for management decisions. For example, fly ash might be managed in a facility with double-liners and double leachate detection/collection systems. This would provide about the same control over fly ash as would management in hazardous waste facilities, but whether it would lower costs is unclear. In addition, standards could be developed for situations in which ash could be used (e.g., in construction materials). The primary drawback of this approach is its lack of flexibility in cases where characteristics of the ash (e.g., variability in leaching potential) or the facility itself (e.g., great distance from groundwater) might make the specified controls unnecessary.

Specify Facility Standards Based on Test Results.—Alternatively, toxicity test results could be used to indicate the type of facility necessary to manage the type of ash. For example, any ash that failed the test might be managed at facilities with double liners and double leachate detection/collection systems. Untreated ash that passed the test might be managed at facilities with single liners and leachate systems.[40] Treated ash that passed the test might be co-disposed with MSW. Conditions under which exclusions were acceptable (e.g., certain site characteristics) also could be determined. This approach would manage ash on an environmental basis (i.e., its potential to leach metals into groundwater). The related problems are the same as those noted above—unreliable tests, the effect of changes in MCLs, and the extra expense of frequent testing. In addition, facility operators will face the uncertainty of not knowing what type of management will be required, even though they often need or want to know what will happen to the ash before a facility is built.

Should Co-Disposal With MSW Be Allowed?—EPA's proposed Subtitle D regulations would not prohibit co-disposal of untreated ash and MSW. The chances of mobilizing metals from untreated ash will almost always be greater in co-disposal situations than in monofill situations, although whether this will always lead to levels of regulatory concern is unknown. As a result, it makes sense to keep *untreated* ash and MSW separate. Whether co-disposal with treated ash should be allowed is uncertain. Treatment technologies appear promising, but additional research on long-term performance is required. Congress could require EPA to sponsor more research on treatment and address this issue in ash management regulations.

[40]After ash is collected (either from the grate or from air pollution controls), it usually is left untreated (i.e., not subjected to any additional special treatment). It can be treated, however, with chemical or thermal processes to make it safer to dispose of or reuse.

Option 2: Clarify the Regulation of Emissions

Although emissions are less controversial than ash management, the only Federal regulations that apply to emissions from MSW incinerators are those that apply to all sources of emissions (e.g., for particulate matter and mercury). Specific performance standards for new MSW incinerators and guidelines for existing incinerators are scheduled to be proposed by EPA in November 1989, but they would not become effective until 1991 at the earliest. Congress could give additional direction to EPA by specifying: 1) whether to base standards on the best available control technologies or on risks; and 2) when, and to what level, to require retrofitting of older facilities.

Option 2A: Choose Standards Based on BACT or on Risks

EPA is regulating new facilities on the basis of guidelines that require the use of best available control technologies (BACT) to control emissions in the interim before it promulgates final emissions regulations. Currently-accepted BACT (e.g., scrubbers, particulate controls such as baghouses or electrostatic precipitators, automatic combustion processes) can enhance the performance of new incinerators and provide much greater control than did previous technologies. It also allows some flexibility in deciding which combination of technologies to use. Congress could allow EPA to continue on this course, either by not addressing this issue or by statutorily defining the use of BACT.

A recent recommendation by EPA Region 10 regarding a permit for a new incinerator in Spokane, Washington, could have significant implications for the definition of BACT, if the recommendation is implemented (EPA, 1989 memo). The recommendation, made in response to opposition from several citizen groups, would include pre-combustion requirements for source separation and recycling as part of the BACT provisions in the permit. This would mark the first time such a linkage between recycling and incineration has been made in a permit. The local solid waste agency has opposed including these provisions in the permit itself, contending that receipt of construction funding from the State already is linked to development of a recycling program, and that the agency already plans to develop a drop-off and curbside recycling program with a 45 percent recycling goal (Env. Rep., April 1989). This situation is a good example of both the opportunities and difficulties of implementing the materials management concepts at the local level.

Whether BACT is sufficient to meet public concerns about potential risks, however, probably will vary from area to area. Some people would like standards to be based on risk, to provide more stringent protection than current BACT. Requiring EPA to develop risk-based standards might help build public confidence and aid in the siting process. On the other hand, a strictly risk-based approach has several disadvantages, including: whether adequate technologies are available to achieve the desired protection, the additional costs of using such technologies, and the uncertainties inherent in risk assessment methodologies and results. The risk-based approach also could lead to fewer controls, depending on circumstances.

Another alternative is to promulgate regulations that require BACT, but that also allow additional, risk-based controls in specific situations. This approach would be similar to that of EPA's water program, which uses standards based on best available technologies and, where indicated by risk-based toxicity testing, additional controls (OTA 1987). It also implies that minimum, as opposed to uniform, regulations would be needed. No matter what form emissions regulations take, they probably will bring higher prices to the municipal users of such facilities. This can be considered as one way of internalizing waste management costs.

A related issue is whether standards should be minimum or uniform. Minimum standards allow States to impose additional and possibly more stringent limitations, which provides the States with the flexibility to respond to specific conditions within their jurisdictions. Uniform standards would mean that the same standards and testing procedures apply to all situations. This would simplify the regulatory process and reduce the number of different tests that companies have to perform to satisfy different State testing requirements. However, it means that States would not have the power to impose additional limitations if they felt Federal standards were not sufficient to protect public health. It is likely that EPA will use the minimum standards approach in its regulatory proposals.

Congress also could require that EPA develop guidelines for training incinerator operators to help ensure greater efficiency and safety. EPA could base these guidelines on the efforts of the American Society of Mechanical Engineers (ASME), which is developing a model training and certification program (EPA, 1989). Congress also could direct EPA to increase its research on the technical and economic feasibility of new emissions control systems and improved monitoring methods (e.g., continuous emissions monitoring methods).

Option 2B: Establish Policies Regarding Existing Incinerators

With respect to retrofitting existing incinerators, Congress could decide whether all old facilities should be required to retrofit, no matter what the cost, or whether some or all should be exempted under certain conditions. If one objective is to reduce potential risks to human health and the environment, old facilities should be required to eventually meet the same or similar standards as new facilities. In some cases, improvements can be achieved with relatively small changes in operating procedures (e.g., computerizing controls, increasing operator training). In other cases, however, retrofitting will involve adding pollution controls (e.g., scrubbers, baghouses). This can be expensive and could lead to some facilities closing, which might reduce risks but would also affect available waste management capacity. One factor that could be considered is the appropriate age of existing plants for which to require retrofitting. Retrofitting may be important, for example, for facilities that have been operating for 5 or more years but that do not meet current BACT standards and are scheduled to continue operating for at least an additional 5 years. For facilities nearing the end of their projected lifetime, retrofitting may not be worthwhile.

Congress could consider innovative means to finance the retrofitting of existing facilities. For example, the Massachusetts Solid Waste Act requires each facility operator to set aside 3 percent of all tipping fee revenues into a dedicated fund that will be used to meet future State pollution control requirements (Mass. DEQE, 1988). Congress could adopt this approach for existing, and perhaps new incinerators, by requiring that a similar provision be included in permit renewals and in new permits.

Landfills

Landfills will always be needed to manage the residues from recycling and incineration, as well as for the non-combustible, non-recyclable portion of the waste stream. Indeed, a continued high percentage of all MSW could be landfilled if the Nation were willing to site or expand more landfills, pay the costs of transporting MSW to these landfills, pay for pollution controls, and accept some unavoidable risks. Some new landfills are being sited, and permitted capacity at existing landfills has been expanded in some cases.[41] In some localities, landfills will remain the primary management method, especially

[41]Landfills must have permits to operate legally; some facilities may have additional space that is not permitted, but such space is not considered to be available capacity.

where recycling and/or incineration capacities cannot be developed economically, or where landfills can be located away from aquifers (e.g., in some arid areas).

Overall, the current decline in permitted landfill capacity seems likely to continue. *Increased landfill capacity cannot be relied on as a nationwide solution to MSW problems, given current attitudes about siting and desires to move toward prevention and other forms of management.*

Implementing a prevention and materials management policy could reduce some associated risks and prolong the life of some landfills. For example, much of the MSW in landfills consists of paper and paper products, yard and food wastes, and plastics.[42] Thus, separating and composting yard waste could divert a large portion of MSW from landfills and reduce some potential leachate problems. Moreover, new landfills that use BACT (e.g., synthetic liners, leachate collection systems) and proper siting procedures can be managed much more safely than could past landfills.

The issues raised by landfilling thus are similar to those for incineration. Two of these issues, the Federal role in resolving siting problems and developing capacity, were discussed above. The primary issue discussed here is how to ensure that new and existing facilities provide adequate public health and environmental protection. Most States have some guidelines or standards for MSW landfills, in some cases based on criteria developed by EPA in 1979, and many older, substandard landfills have closed instead of being upgraded to meet these standards. EPA is revising recently proposed regulations for the design, operation, and location of Subtitle D landfills. Congress could provide additional direction to EPA, particularly guidance on whether the regulations should use a risk-based or design-based approach and whether they should apply to facilities that close before the standards become effective. Congress also could clarify the issue of municipal liability for corrective action.

Option 1: Give Additional Direction to EPA's Regulatory Effort

Option 1A: Specify How Landfills Should Be Regulated

The regulations currently proposed by EPA do not require the use of BACT. Instead, they would allow States to regulate each aquifer with a different risk-based standard, so long as the associated cancer risk fell below a specified range. Depending on the risk level chosen for a given site, some new landfills might be built without liners or leachate collection systems. This flexibility may be desirable, but the range of allowable risks is wide (between one additional cancer death per 10,000 people and one per 10,000,000 people), and EPA provided little guidance on which design features would meet particular risk-based standards.

Congress could endorse this risk-based approach, or it could direct EPA to specify uniform design criteria based on BACT, and thus provide clearer direction to communities and States about how new landfills should be built. The major problem with a design-based approach is its lack of flexibility, particularly for sites located in arid areas, far from an aquifer, or in special geological areas. This problem could be addressed, however. For instance, site-specific variances from uniform criteria could be allowed, assuming that the alternative provides a similar level of protection. Alternatively, EPA could specify different design features for use in different situations, although this might prove to be a formidable task given the variability in site characteristics.

[42]These materials represent about two-thirds by weight of the waste in landfills. OTA cannot be specific about the average total volume that these materials comprise because data are lacking on the composition by volume of MSW entering landfills.

Option 1B: Extend Corrective Action and Closure Requirements

Some MSW landfills have been associated with environmental problems (e.g., groundwater contamination), and it is possible that more will cause problems in the future. EPA's proposed regulations include corrective action, closure, post closure, and financial assurance requirements to help remedy future problems. Existing landfills that close within 18 months after the regulations are promulgated, however, would not be subject to the corrective action requirements unless State regulations require otherwise. As a result, the rate at which substandard facilities close is likely to increase because they could avoid potentially expensive closure and corrective action procedures. Congress could address this issue by directing EPA to consider making all existing landfills subject to the requirements at the time the regulations are promulgated. While this would impose substantial costs on some landfill operators, it would provide for the orderly closing of substandard facilities and avoid some of the problems discussed in Option 2 below.

Option 2: Clarify Municipal Liability Provisions

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund) currently can be used for remedial actions at landfills, and indeed 20 percent of the sites on the National Priorities List (NPL) are municipal landfills.[43] Although local governments do not relish the idea of having their landfill on the NPL, Superfund does provide two advantages to municipalities—a source of funding for cleanup, and the sharing of liabilities for cleanup and corrective action among industrial waste generators, transporters, and local owners and operators.

In proposed amendments to CERCLA, however, EPA suggested deferring the listing of additional municipal landfills on the NPL after corrective action requirements under subtitle D of RCRA are issued (53 *Federal Register* 51394, Dec. 21, 1988). This deferral policy would apply only to currently active landfills, not to previously closed ones. It would require that active landfills meet financial responsibility requirements for cleanup to assure some funding for remediation efforts that do not fall under Superfund.

One important consequence of this proposed policy, however, is that it would make local landfill owners and operators liable for corrective action and cleanup costs, instead of sharing liability with waste generators and haulers.[44] This policy is supported by representatives of industrial waste generators, who contend that MSW alone can generate toxic leachate and that corrective action at municipal landfills should be handled under a separate program (Webster 1988).

The disadvantage to municipalities is that the costs of identifying, ranking, and cleaning up Superfund-type sites are high (OTA 1985, 1989), and few municipalities are likely to be able to bear such costs. Moreover, most municipalities have either expected to share liabilities with waste generators and transporters or been unaware of their liabilities under Superfund. The position of organizations representing municipalities (e.g., National League of Cities, Governmental Refuse Collection and Disposal Association) is that Superfund should continue to be used for corrective action and cleanup of municipal landfills (Steinzor 1989).

Congress could allow EPA to continue developing the deferred listing policy, in conjunction with development of corrective action requirements under proposed Subtitle D criteria. If

[43]The NPL is the list of sites designated by EPA for cleanup action under the auspices of the Superfund program.

[44]At least initially, this would be true. In theory, however, the costs could later be recovered through legal action against waste generators, but some argue that in practice this would be unlikely (Steinzor 1989).

Superfund is not used for cleanup of additional municipal landfills, one possibility for easing the financial burden on municipalities is for States to place a tax on tipping fees at all landfills. Revenues could be placed into trust funds to support corrective action programs. This approach is being tried in some States (e.g., Massachusetts).

Alternatively, Congress could direct EPA to revise the proposed amendments, specifically to continue including municipal landfills in Superfund. Another alternative is to allow States to petition EPA to defer individual sites. In this approach, site-specific conditions would be considered and the deferred site would be handled under other programs. The position of the municipal representatives on this approach is that, if it is adopted, States should be required to obtain the concurrence of the local government owner and operator when a municipal site is considered for deferral.

A longer-term approach to avoiding such problems is to keep certain materials out of landfills. For example, localities could be encouraged to remove and compost yard wastes, which would reduce the probability that leachate will cause problems. Some States have banned the disposal of such materials in MSW landfills if composting facilities are available. The disposal of industrial wastes and small quantity generator hazardous wastes at MSW landfills also could be phased out as other management capacity for these wastes is developed. In the interim, landfill operators could be required to meet stricter standards and provide better records if they accept such wastes.

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Box 1-A—MSW DEFINITION AND DATA NEEDS

Municipal solid waste (MSW) is solid waste generated at residences, commercial establishments (e.g., offices, retail shops, restaurants), and institutions (e.g., hospitals and schools). This waste may be categorized as materials (e.g., glass, paper) or products (e.g., appliances, containers, tires). For purposes of this report, MSW does *not* include construction or demolition debris or automobile scrap.

Solid waste is defined in RCRA (Section 1004 (27)) as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities . . ."

ESTIMATES OF MSW GENERATION

EPA has estimated that total MSW generation in the U.S. is over 160 million tons in 1986, and that it is rising at a rate of about 1 percent each year. These estimates are based on a materials flow model (referred to here as the EPA/Franklin model). Figure 1 shows the model's estimates of the composition of MSW by weight, in terms of different materials and products.

Most of the increase in the generation rate is attributable to population growth. However, each person also appears to be generating more waste on average. The EPA/Franklin model estimates that each person in the United States generated 3.6 pounds of garbage per day in 1986; this is expected to grow to 3.8 pounds by 2000.

Determining actual MSW generation rates is difficult. Some evidence indicates that the average generation rate per person may be higher than the model's estimates. Different studies report widely different rates, and use different definitions. For example, it often is not clear whether industrial waste and demolition debris are included in calculations.[1] This lack of consistent definitions and procedures for measuring, calculating, or reporting MSW data makes it difficult to aggregate existing local and State data or to compare them with the EPA/Franklin estimates.

Problems caused by inconsistent definitions and data collection techniques also make it difficult to compare generation rates among countries. It is often stated that the United States produces more MSW per person than do other industrialized countries. This may be true—after all, the United States has high rate of purchasing products—but the magnitude of such differences cannot be reliably estimated with current data.

National estimates of total MSW generation in the United States also are not particularly useful for local decisionmaking. *From a local perspective, information about the generation and composition of MSW in local communities is much more critical for making decisions about capacity needs and management options.* For example, overall generation in a given area affects what size of landfill or incinerator is needed; the types of products and materials in the MSW influence planning for recovery of materials for recycling; and variations in composition can affect incinerator design.

DATA AND RESEARCH GAPS

Underlying Factors.—Many potentially important underlying factors that affect MSW generation have not been investigated extensively. Few studies have looked at how degree of urbanization, socioeconomic status, or family size affect generation and composition. Little has been done to document trends in the production of single-use, disposable items, or to document the relative contributions from the residential, commercial, and institutional sectors. Without more detailed analyses of such factors, it will be difficult to focus educational efforts to change consumption patterns and reduce MSW generation rates.

Weight and Volume.—Better data on the weight of MSW components are needed to make decisions about recycling and incineration. For example, prices for secondary materials are usually quoted on a weight basis, so officials who have data on individual components can estimate potential revenues. On a national basis, the largest categories of MSW by weight are estimated to be paper products, yard waste, and food waste.

Data on volume tend to be useful for evaluating landfill capacity, collection vehicle capacity, and the feasibility of quantity reduction. *Unfortunately, most studies have not gathered data on the volumes of different materials in MSW prior to disposal.* Excavation studies at several landfills have provided some data on MSW volume after it has been landfilled for several years; these excavations show that paper and plastics are the largest components by volume.

Calculating Recycling Rates.—Calculating recycling rates for the Nation is also problematic. EPA's estimate that about 10 percent of MSW is recycled excludes materials and products such as demolition debris and automobiles. Some observers contend that these should be included, which would raise the overall recycling rate

considerably. For example, approximately 12 million tons of steel were recycled from automobiles in 1983; this would almost double the EPA/Franklin estimate of tonnage recycled.

Some observers also suggest that recycling "new" industrial scrap should be included in calculations of MSW recycling. However, while scrap may be recycled at the same facilities that recycle secondary materials recovered from MSW, it does not comprise MSW and should not be used to indicate higher MSW recycling rates.

[1]For example, industrial waste might make up 10 percent or more of all waste received at MSW landfills. As new regulations (under RCRA) regarding the on-site management of industrial wastes become more stringent, it is possible that industrial disposal at MSW landfills may increase.

Box 1-B—THE RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) is the major Federal statutory authority addressing solid waste, including MSW.[1] Key provisions of RCRA are described here, but it should be noted that many of these programs were not implemented or have not been functional since the early 1980s.

A major focus of Subtitle D (Subchapter IV of RCRA) is to encourage the *development of State solid waste management plans* and to foster intergovernmental (Federal, State, and local) and public/private cooperation (Section 4001). Federal technical and financial assistance are offered to States and localities as incentives for them to develop plans (Sections 4002-4003, Sections 4006-4008).

In 1984, the Hazardous and Solid Waste Amendments (HSWA) to RCRA added a method for EPA to encourage *compliance of State plans with Federal guidelines*. Specifically, EPA may use its enforcement powers under the hazardous waste provisions of RCRA if a State fails to implement permit programs for solid waste facilities receiving hazardous wastes from small quantity generators and/or household hazardous wastes (Section 4005(c); see also Section 3001(d)).

Another major focus of Subtitle D is *the improvement of landfills*.[2] EPA is authorized to promulgate regulations containing criteria to classify types of sanitary landfills (Section 4004), to facilitate the closing or upgrading of existing open dumps (Section 4005), and to provide assistance for these activities to rural communities (Section 4009). HSWA directed EPA to survey solid waste management facilities across the Nation and evaluate whether current guidelines and standards are adequate to protect human health and the environment, as well as to revise the landfill guidelines.

RCRA also contains *a substantial research, development, demonstration and information subtitle* (Subchapter VIII). In addition to establishing broad research authorities for EPA, alone or after consultation with the Secretary of Energy (Section 8001), this subtitle identifies special studies to be supported (e.g., on glass, plastics, tires, waste composition, small-scale technology, and source separation) (Section 8002). Section 8003 identifies a comprehensive list of topics for which the EPA is to "develop, collect, evaluate and coordinate information." This includes information on methods to reduce the amount of solid waste generated, the availability of markets for energy and materials recovered, methods and costs of collection and management practices, and research and development projects for solid waste management.

A central reference library was to be established and maintained to house this information and other relevant data on the performance and cost effectiveness of various waste management and resource conservation technologies and systems (Section 8003(b)). *Full-scale demonstration facilities and grants* for resource recovery systems and "improved solid waste disposal facilities" programs also were to be established (Sections 8004-8006).

Procurement guidelines were to be prepared by the EPA, after consultation with the Administrator of General Services, the Secretary of Commerce, and the Public Printer (RCRA, Subchapter IV). The guidelines should designate items produced with recovered materials that must be procured by Federal agencies; recommend practices for the procurement and certification of such items; and provide information on the availibility, relative price, and performance of such items (Section 6002(e)). EPA was required to prepare guidelines for paper and three other product categories, including tires, by 1985. In addition, each procuring Federal agency is required to establish a procurement program (Section 6002(i)).

In addition to EPA, the other Federal agency given major responsibilities under RCRA is the Department of Commerce (Subchapter V). Four special areas of responsibilities are delineated: 1) to develop accurate specifications for recovered materials; 2) to stimulate and develop markets for recovered materials; 3) to evaluate and promote proven energy and materials recovery technologies; and 4) to establish a forum for the exchange of technical and economic data relating to resource recovery facilities (Sections 5001-5005).

[1]P.L. 94-580 (1976). Congress first established a Federal role in solid waste issues in the Solid Waste Disposal Act of 1965 (P.L. 89-272; as amended by the Resource Recovery Act of 1970, P.L. 91-512). RCRA was revised most recently by the Hazardous and Solid Waste Amendments of 1984 (P.L. 98-616) and is in the process of further revision and reauthorization.

[2]Subtitle D also addresses other facilities, including nonhazardous industrial waste landfills, land application units, and surface impoundments.

Box 1-C—EPA'S AGENDA FOR ACTION

EPA's report, "The Solid Waste Dilemma: An Agenda for Action," concluded that "to the extent practical, source reduction and then recycling are the preferred options for closing the gap [between waste generation and management capacity] and reducing the amount and toxicity of waste that must be landfilled or combusted" (EPA, 1989). In the report, EPA set a national goal of achieving 25 percent source reduction and recycling by 1992, and estimated that incineration would handle about 20 percent and landfilling about 55 percent of MSW at that time. EPA also developed specific objectives and outlined its future activities, as briefly described here:

Increase Information
- develop educational and technical materials
- sponsor national conference on research and development
- establish a clearinghouse for information
- establish a peer matching program

Encourage Increased Planning
- help States develop strategies (workshops, selected State plan reviews)

Encourage Increased Source Reduction Activities
- promote toxicity reduction (e.g., studies, testing guidelines, options regarding lead and cadmium)
- promote quantity reduction (studies, corporate recognition, workshops)
- procurement of products with source reduction attributes
- study source reduction policies

Participate In and Encourage Increased Recycling
- stimulate markets (e.g., studies on markets and incentives, guidelines for composting, Federal Task Group for implementing procurement)
- promote better separation and processing (model training and education programs, options for batteries and appliances, interagency work group)
- facilitate formation of a national advisory council
- review hazardous waste liability issue

Help Reduce the Risks of Combustion
- upgrade combustor performance standards and ash management
- decide whether to develop model operator certification program
- provide information on problem wastes

Help Reduce the Risks of Landfilling
- operator certification (training, State certification guidance)
- issue final criteria on design and operation
- technical guidance on revised criteria
- provide information on problem wastes

Box 1-D—THE MSW "SYSTEM"

The "system" that produces MSW is complex and dynamic, and different parts of it are linked together in ways that are not always clear. Illustrating the elements of the system can help identify leverage points at which strategies can be developed and options applied most effectively.

1) Materials/products lifecycle
   - products: design, production, distribution, purchase, use, discard
   - non-product materials (yard and food waste): generation, discard
   - management: collection, processing, treatment/disposal

2) Actors that touch materials and products
   - designers, manufacturers, distributors, retailers
   - waste managers (haulers, landfills, incinerators, recyclers)
   - citizens (purchase, generation, siting decisions)

3) Private infrastructure
   - collection system, reclamation/other processing (e.g., scrap industry)
   - landfills, incinerators, recycling facilities
   - structure of waste management industry
   - structure and dynamics of materials industries
     - — dynamics of prices and disposal costs
     - — international aspec
   - financial sector

4) Public institutional struct
   - local decisionmaking and infrastructure
   - collection programs, reclamation/other processing
   - landfills, incinerators, recycling facilities
   - government programs
     - — dynamics of Federal & State roles and plans
     - — subsidies and incentives (e.g., PURPA, tax credits)
     - — effects on private sector

5) Social attitudes
   - value judgments
     - — about environmental protection and health effects
     - — about product design and consumption
   - resource policies
     - — extent to which Federal government involved
     - — how the Nation deals with materials and energy policies
   - siting of facilities, degree of acceptable risks
   - economic factors (e.g., internalizing costs)

Box 1-E—GENERAL MARKET FACTORS

Recycling—despite its promise as an important element in a MSW prevention and management strategy—has two important caveats that policymakers should consider. First, policymakers should be aware of the distinction between supply-limited and demand-limited materials. Second, they should be aware that market prices for secondary materials can fluctuate dramatically. In addressing the first issue, Federal activities should be flexible to distinguish between materials that are not being recycled at a high level because they are either supply-limited (i.e, are not collected in sufficient amounts or are too highly contaminated for current manufacturing processes) or ***demand-limited*** (i.e., buyers are relatively scarce even though supplies may be available). This distinction matters from a Federal perspective because some options may be ineffective if applied indiscriminately to all types of materials. The distinction generally does not apply to the private sector because from that perspective the market sets the prices required to bring forth needed supplies. The market does not assure that all sources of supply are being tapped, however. In this case, for example, a valuable source of supply of raw materials exists in MSW, but the potential supplier (i.e., waste generator) is not always aware of the value of those materials.

These distinctions also are time-dependent. Markets are constantly in flux, and a material now in short supply could be in oversupply at a later date. Materials in MSW considered as supply-limited in 1989 include old corrugated containers, office papers, single-resin plastics, glass, tin cans, and aluminum. Demand-limited materials include old newspapers, mixed papers, mixed plastics, used oil, tires, compost, and ferrous scrap other than tin cans.

Second, the 1988-89 market environment has some materials priced at or near their peak levels. Given the history of fluctuation in most materials markets, recycling decisions should not be made only on the basis of current prices. Of course, markets will always exist for most materials. The question is: where will contractions in the system occur when demand declines? The existing private infrastructure has substantially increased collection rates for many materials (e.g., aluminum, glass, and paper). However, increased municipal collection of MSW provides a supply of materials that is not sensitive to demand. In some cases, these materials will be made available even at negative prices because municipalities can afford to pay manufacturers to take collected materials as long as the fee is less than disposal would cost. As a result, private sector suppliers are likely to be less competitive and to constitute "marginal" supply sources during times of declining demand to a wider extent than ever before. Efforts to manipulate markets, therefore, must consider potential effects on employment and tax revenue generated by private sector suppliers.

Box 1-F—MARKETS FOR RECYCLED MATERIALS

About 10 percent of MSW was recycled in 1986 (Franklin, 1988). Although this figure may seem small, it masks a great deal of activity in the recycling arena. In fact, by some estimates, recycling rates may be higher than those estimated by Franklin for particular materials (fig. 5). For most materials, many opportunities exist to increase materials recovery from MSW, both in the short and longer terms. The state of the economy, both nationally and globally, will play a large role in determining whether these opportunities will be realized.

Recycling is the management alternative that traditionally goes the farthest beyond the Federal government's purview. Carefully tailored policy options may help stimulate these markets, but blanket policies that address all materials equally may be ineffective and, even worse, wasteful.

Aluminum constitutes only 1 percent of MSW, but it has a recycling rate of between 25 percent and 45 percent. Aluminum cans, almost 80 percent of all aluminum in MSW, are recycled at a 55 percent rate. The technology and economic incentives exist to enable a significant increase in this recovery rate. The major barrier is the inadequacy of the collection process.

Paper and paperboard, comprising 41 percent of total MSW discards, are recovered from MSW at a rate of 22 percent to 28 percent. Some short-term opportunities exist to increase this rate, particularly for tissue, newsprint, and linerboard, but technical and capacity barriers may delay more dramatic increases.

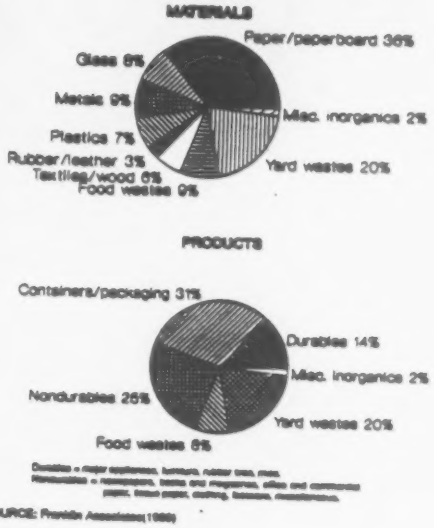
Glass, mostly containers, accounts for about 8 percent of MSW and is recovered at a rate of 10 percent to 15 percent. The glass industry is actively expanding processing capacity for post-consumer glass (known as cullet), which in many cases can reduce the cost of producing glass containers. Technically, when colors are separated, 100 percent cullet can be used in making new containers, considerably more than the current industry average of 25 percent (which includes industrial scrap).

Iron and steel account for about 7 percent of MSW and are recovered at a rate of 4 percent to 20 percent. Some potential exists for increased recycling of steel cans, which account for about one-third of ferrous scrap. Recent increases in detinning capacity will improve the recycling rate for "tin" food cans, and major steel mills are gearing up to increase consumption of bimetal (steel and aluminum) beverage cans. Recovery of other ferrous scrap is not likely to expand significantly, because supply from other sources is abundant and growth in demand is limited.

Plastics, which make up about 7 percent by weight of MSW, have the lowest recovery rate among MSW components—only about 1 percent. Recycling of post-consumer plastics is in its infancy, with most efforts focussed on two resins (PET and HDPE). However, considerable market potential exists for increased recycling of these and other resins. The plastics industry also is making a major effort to develop recycling collection/processing systems.

Yard and food waste is an important part—about one-fourth—of MSW, but only negligible amounts of these materials are composted. However, composting is now receiving considerable attention, and a number of localities are considering it as an alternative to incineration or landfilling. Marketability will be determined largely by the quality of compost.

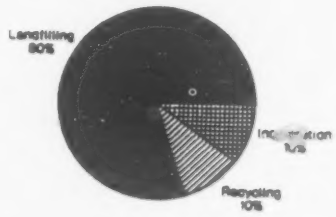
Figure 1—Estimated Portions of Materials and Products in MSW, 1988, by Weight



Durables = major appliances, furniture, rubber tires, misc.
Nondurables = newspapers, books and magazines, office and commercial paper, tissue paper, clothing, footwear, miscellaneous.

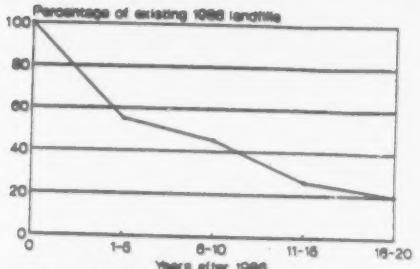
SOURCE: Franklin Associates (1988)

Figure 2—Use of Management Methods



SOURCE: After Franklin (1988)

Figure 3—Estimated Decline in Existing Permitted Landfills



NOTE: Based on estimate of 6,034 landfills; data for years 1-5 include an estimated 535 closings in 1986-87.

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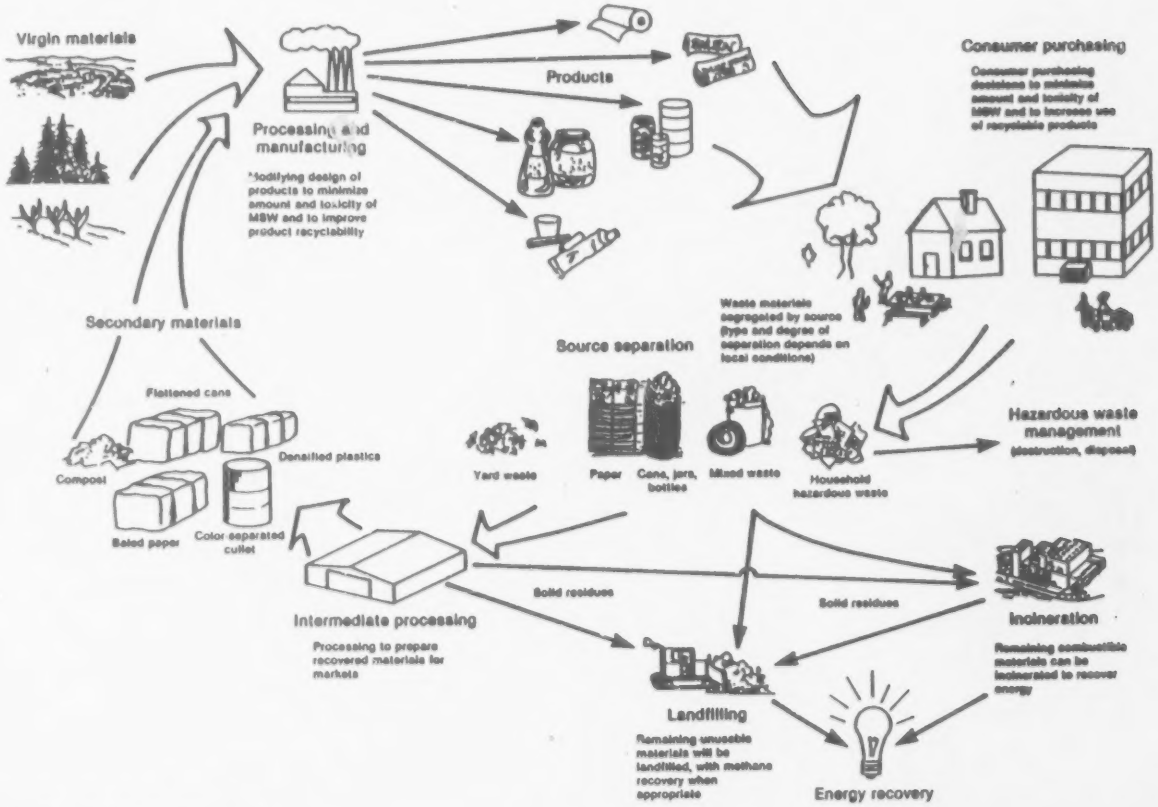
Figure 4.—Waste Prevention and Materials Management Approach

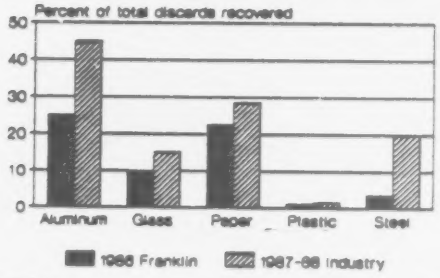

Virgin materials
Processing and manufacturing
Modifying design of products to minimize amount and toxicity of MSW and to improve product recyclability
Products
Consumer purchasing
Consumer purchasing decisions to minimize amount and toxicity of MSW and to increase use of recyclable products
Waste materials segregated by source (type and degree of separation depends on local conditions)
Source separation
Secondary materials
Flattened cans
Densified plastics
Compost
Baled paper
Color separated cullet
Yard waste
Paper
Cans, jars, bottles
Mixed waste
Household hazardous waste
Hazardous waste management
(destruction, disposal)
Intermediate processing
Processing to prepare recovered materials for markets
Solid residues
Solid residues
Incineration
Remaining combustible materials can be incinerated to recover energy
Landfilling
Remaining unusable materials will be landfilled, with methane recovery when appropriate
Energy recovery

SOURCE: Office of Technology Assessment, 1989

Figure 5—The "Environmental Angel" Logo

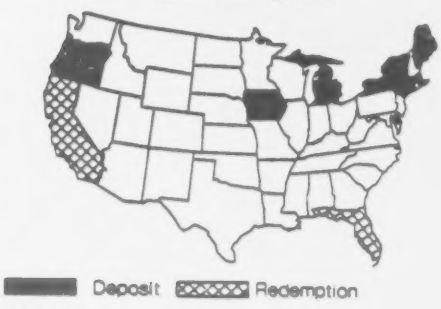
SOURCE: Deutsches Institute für Gutesicherung und Kennzeichnung E.V. (DIN 1988)

Figure 6—MSW Recycling Rates: Franklin v. Industry Estimates



SOURCE: Franklin (1988), Aluminum Association (1988), Cooperative (1988), API (1988), SPI (1988), Steel Can Recycling Institute (1988).

Figure 7—States With Deposit or Redemption Systems



SOURCE: OTA

Table 1-1—Potential Policy Options and Activities for MSW

Category	Issue	Option
Enhance Institutional Framework	Integration: Planning and Coordination	Require State MSW Management Plans Improve Interagency Coordination
	Ensuring Capacity: Siting, Interstate Transportation	Allow Barriers to be Imposed on MSW Imports Require States to Ensure Adequate Management Capacity Develop Model Siting Procedures
	Enforcement	Define Stronger Role for EPA in Enforcement
	Improving Flow of Information	Information Clearinghouse Education Increase Federal Research
	Funding	Product Fees User or Waste-End Fee National Income Tax
Waste Prevention	Developing National Goals and Assuring Them High Priority	Goals to Reduce Quantity Goals to Reduce Toxicity Assure High Priority in Federal Agencies
	Providing Economic and Other Incentives	Grant Fund High-Visibility Awards Federal Procurement
	Improving Information Flow	Develop Labeling With Reduction Information Data on MSW Generation
	Banning Specific Products and Substances	Ban
Recycling	Increasing Information and Education	Improve Collection, Dissemination of Information Increase Education Awards for Product Design and Labeling
	Research and Development	Funding for Research
	Standardized Definitions, Labeling, and Avoided Cost Calculations	Standardize Definitions and Testing Procedures Standardize Guidelines for Labeling Standardize Avoided Cost Calculations
	Regulations for Recycling Facilities	Ensure Adequate Regulation of Recycling Facilities Resolve Conflicts with Hazardous Waste Regulations
	Market Development	Procurement Programs Direct Subsidies Economic Development Building Export Markets
	Fees and Pricing Policies	Rate of Progress Fees on Manufacturers Increase Cost of Alternatives Product Charges
	Requiring Secondary Materials Recovery and Reprocessing	Deposit Legislation Require Use of Secondary Materials Require Source Separation Programs Bans National Stockpile of Secondary Materials
Incineration	Clarifying Ash Management	Clarify Household Waste Exclusion Decide How to Manage Ash Under Subtitle D
	Clarifying Emissions Regulation	Choose Standards Based on BACT or on Risks Establish Policies Regarding Existing Facilities
Landfills	Giving Additional Direction to EPA's Regulatory Effort	Specify How Landfills Should be Regulated Extend Corrective Action and Closure Requirements
	Clarifying Liability Provisions	Clarify Superfund Listing Policy